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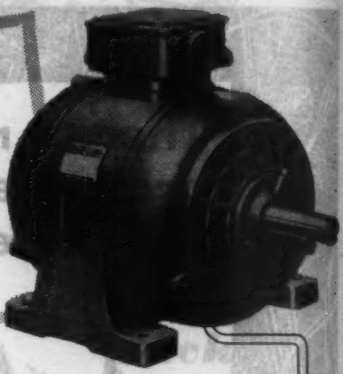

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Agriculture

Volume LXIV Number 2 May 1957

EDITORIAL OFFICES
THE MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
WHITEHALL PLACE · LONDON S.W.1 · TRAFALGAR 7711

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Ploughing-oxen owned by the Earl of Bathurst (see p. 96)

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The Outlook for Home-grown Fruit

C. E. PEARSON, N.D.A.

Ministry of Agriculture, Fisheries and Food

Mr. Pearson considers the trends in fruit production and marketing during the past four years and the need in the future for a closer relation between production and probable changes in consumer demand and taste.

ALTHOUGH last season's early promise of another heavy fruit crop with records for dessert apples and pears was broken by the disastrous storms of the summer, it confirmed the trends that were outlined in this JOURNAL four years ago.* It was shown then that over the preceding five years, home production of all kinds of market fruit (excluding cider fruit) had averaged nearly 690,000 tons, or more than 50 per cent above the pre-war level, and that the figure was likely to go on increasing for at least another ten years. Since then the average has in fact risen by a further 20,000 tons, but as the figure is no more than an average, and growers are continually improving their methods of cultivation, it must inevitably rise higher still and in a favourable year may reach 850,000 tons or more. All kinds of fruit have shared in the rise, but dessert apples have made the most spectacular contribution and there are many who foresee great difficulties in marketing such large totals and consider that the problems involved in handling such a high proportion of dessert apples are alarming. But there is no reason why this need be so.

Apples

For nearly twenty years the total acreage of dessert and cooking apples and the number of trees grown have remained almost unchanged, yet within the totals a revolution has taken place. The periodic fruit censuses show what has been happening; a steady fall in the number of cooking apples has been roughly equalled by a rise in the number of dessert apples, and in both cases there has been a marked concentration on the popular varieties. Of 10 million dessert apples, 70 per cent are Cox's Orange Pippin and Worcester Pearmain and 70 per cent are less than twenty-one years old; of 4½ million cooking apples, 40 per cent are Bramley's Seedling, but less than a quarter are under twenty-one years old. Other statistics show how these changes in the make-up of the total area have affected production, and by reading the two sets of figures together, and making full allowance for the continuing effects of improved methods of growing and handling, it is possible to get a fairly reliable estimate of what further changes are likely to occur in the near future.

In the case of cooking apples, improved methods and the comparatively

* The Post-war Pattern of Horticulture in England and Wales. C. E. PEARSON, *Agriculture*, 1953, 59, 508–15.

long cropping life of the principal varieties have counteracted the effects of the fall in the number of trees, so that production has become remarkably constant for a horticultural product, giving an average of about 270,000 tons a year, or roughly double the pre-war level. The figure is unlikely to change materially for some little time because the proportion of young trees is low, and the wastage of the older trees is now far less than it was ten years ago, when systematic grubbing had scarcely begun. As approximately two-thirds of the total consist of long-keeping varieties and modern storage can prolong the marketing season by several months, there should be no additional problems about disposal.

With dessert apples, the difficulties are greater and not so easily solved. The marketing season for the home crop is comparatively shorter, there is direct competition from imports, and consumer preference exerts a stronger influence. Production in the past five years has averaged nearly 200,000 tons or roughly three times the pre-war level, and as a result of improved methods and the high proportion of young trees, it will go higher yet. Nearly the whole quantity must be marketed within a period of six months, during which additional supplies—averaging 30,000 tons over the last five years—come in from overseas. This means that the total quantity for marketing in the immediate future may reach 250,000 tons, or even more. Such a figure is not abnormal for modern times.

Demand

For many years before the war, demand for dessert apples had established a well-defined pattern. Sales ran at a high level from the beginning of the season until early December, when they declined (contrary to popular belief, apples are not the favourite of Christmas fruits), and then continued at a lower level until the season came round again. In those days the home crop provided only a small proportion, and with a comparatively low production of late-keeping varieties and storage capacity of little more than 20,000 tons, the quantity left for marketing after November was negligible. The bulk of the supplies during the home season came from Canada and the U.S.A. and, as there were then no financial restrictions on imports, the quantities came in according to market requirements and the size of the home crop, the total being determined by consumer demand. Since the war there have been specific restrictions on overseas supplies, particularly from North America, but the home grower has, to a large extent, filled the gap and the pattern of marketing is now not very different from what it was.

Average Supplies of Dessert Apples (*thousand tons*)

	Pre-war			Post-war		
	Home Supplies	Imports	Total	Home Supplies	Imports	Total
Aug.	10	4	14	15	3	18
Sept.	20	17	37	45	1	46
Oct.	20	42	62	50	3	53
Nov.	15	43	58	40	5	45
Dec.	5	30	35	30	6	36
Jan.	—	30	30	10	14	24
Total	70	166	236	190	32	222

The consumer is not yet eating as many dessert apples as before the war, and there was nothing in those days to show that supplies were, on average, too large. Indeed, consumption had risen steadily but slowly from the beginning of the century, and had it not been for the war would probably have continued unchecked. Even had it remained stationary, the increase in population would now require an additional 25,000 tons, so that there would be nothing remarkable about a present-day consumption of at least 260,000 tons for the six-months' period, and the figure might well be higher. To provide between 220,000 and 230,000 tons of the total, the home grower must have a *gross* production of about 270,000 tons to allow for wastage and normal losses in store.

Timing

Since 1900, consumer demand has not only established a marketing pattern which it would be difficult and foolish to ignore, but has also shown that the steadiest increase in sales occurs among those products which appear in the shop windows all the year round—oranges, tomatoes, bananas—and apples. For these products demand has risen by between 100 and 200 per cent, while for the more seasonal fruits and vegetables the increase has been between 30 and 50 per cent only. There is no doubt that a continuous supply is its own advertisement, always provided that quality is maintained and that what is offered is in fact what is wanted. There is now no reason why this requirement cannot be satisfied, for the home grower has proved that he can produce heavy and reasonably regular crops of good quality, and has the necessary amount of storage space to maintain supplies until the end of January, and even later. If the total supply can be spaced out in accordance with the marketing pattern demanded by the consumer, there should be no serious problem. It happens, possibly by chance as much as by design, that the present composition of the home crop is such that this can be done. Approximately 15 per cent of the total is produced by early varieties, 45 per cent by Worcester Pearmain and other mid-season varieties such as Lord Lambourne and Ellison's Orange, and 40 per cent by Cox's Orange Pippin and other late-keeping varieties, of which Laxton's Superb is the most important. If all these groups were marketed in their proper seasons and not offered before or after they are fit, there would be no special difficulties even in a heavy year.

Pears and other tree fruit

The position of pears is very similar to that of dessert apples. There is every prospect that the quantities for marketing in the immediate future will continue to increase and rise substantially above the pre-war levels. More than half the number of trees are under twenty-one years old, and of the total, half consists of Conference. The quantity which can be expected to come on the markets during the home season will be about 70,000 tons, comprising 50,000 tons from the home crop and nearly 20,000 tons as the average for imported supplies. The total is some 30,000 tons more than the pre-war figure, but the demand is far greater and shows every sign of continuing to increase. Storage must be more fully used to relieve the pressure on the markets during October and November.

The early forecasts for the past season also confirm the trends that were seen four years ago. Most of the changes in the post-war years follow changes in consumer demand. Production of cherries is likely to go on rising, but there is an increasing demand to meet it, while the production of early- and mid-season cooking apples and plums must slowly decline, since demand is moving the same way. In the one case there is a high proportion of young trees, in the other the numbers are low, and there should be no serious difficulty in selling.

Soft fruit

Among soft fruit the one great problem is with black currants. By 1950 the post-war urge to plant had raised the area to over 16,000 acres, and in 1952 production reached nearly 27,000 tons, both figures being all-time records. It was not surprising therefore that in 1955 the area fell to 10,000 acres. This was too low and now, once again, there is a rush to plant up. This is the one tragedy of modern fruit-growing, for here is a crop which under up-to-date methods of cultivation gives a fairly steady production, has well-defined outlets and should therefore be easy to plan and market. Yet so far it has proved impossible to relate area with demand.

The future

The changes in the present area and production of the different fruits, as compared with twenty years ago, are not in themselves remarkable. They merely reflect changes in consumer demand. Nor are they as yet alarming, but it is clear that for the future the most careful consideration must be given to a still closer relation between production and the probable changes in consumer demand and taste. If this is not done, then surpluses of one or another kind of fruit are inevitable and will possibly last for years because the raw materials, the trees, cannot be altered overnight. The past has many examples—the long under-production of dessert apples and the over-production of cooking apples and plums. But the present and the future, with their vastly improved methods of growing and the development of storage techniques, offer a more steady production and a longer marketing season. There seems no reason to alter the conclusions that were drawn four years ago. Planting of dessert apples, pears, dessert plums and cherries should go on at a rate sufficient to maintain, but not increase, the existing areas; planting of late-keeping cooking apples, such as Bramley's Seedling, should be stepped up, for the areas of young trees are below maintenance levels. The areas of soft fruits should be at least maintained because although yields are now, on average, higher and more regular than before the war, there is no sign that demand has yet been over-supplied. But since soft fruits are comparatively short-term crops, sudden changes in acreage must always be avoided.

A Case for Field Beans

M. J. WAY, M.A.

Rothamsted Experimental Station, Harpenden

The writer sees no reason why more field beans should not be grown. Yields of 20–25 cwt per acre should be obtainable if the results of recent work on fertilizer practice and insect pest control are applied.

WHY aren't field beans more popular? Experimental work on field beans during the last ten years has partly remedied previous neglect but, despite some encouraging results, the crop has not gained favour with the farmer. Mr. M. B. Jawetz, an economist at the University of Wales, writing on the subject in this JOURNAL last April,* suggested that beans are uneconomic and that land can generally be better utilized by cereal crops. This seems to be a harsh judgment. It was based on estimates of the relative costs of production and feeding values per acre of beans and cereals, assuming an average bean yield of 14 cwt per acre costing from 50 to 69 per cent more to produce than the same weight of a cereal. However, before field beans are condemned, two questions should be considered—first, is an average yield of 14 cwt per acre as much as can be expected, and second, are beans a crop to be encouraged for reasons other than their grain yield?

Yields and crop management

An average yield of 14 cwt per acre indicates that many farmers are not giving the crop enough attention and that the results of recent experimental work are not being implemented.

The practice of sowing beans only after the cereals have been drilled is partly the cause of low yields, for there is now abundant evidence that the crop suffers severely from late sowing. In experiments at Rothamsted, a three weeks' delay in sowing depressed winter bean yields by up to 6 cwt per acre, late-sown winter beans sometimes failed, while yields of spring beans were invariably depressed, the extent depending on the season and severity of blackfly attack. When blackfly is controlled, yields from mid-April sowing may be 5 cwt per acre less than those from mid-March sowing; in the absence of blackfly control, yield can be more than halved by the month's delay in drilling. Early drilling is not impracticable. Spring beans can sometimes be drilled when the soil is still unfit for sowing cereals, and early sowing would be easy for those who still plough in their seed.

There is a misconception that field beans can fend for themselves. Often little attempt is made to control weeds, and surveys of fertilizer practice at Rothamsted and at Oxford have shown that up to 50 per cent of fields

* More Beans for Stock-feeding? M. B. JAWETZ, *Agriculture*, 1956, **63**, 308–11.

receive neither dung nor artificial manures; also, it is not always realized that an acid soil is deleterious. Admittedly, although beans benefit from dung, they have shown no response to nitrogen and often little or none to potash or phosphate, unless there was a marked deficiency. Recently, however, Rothamsted work has demonstrated that fertilizer placement gives yield increases which justify the routine application of quite small quantities of potash and sulphate.

It seems probable, therefore, that improved husbandry would lead to a useful increase in average yields, but there still remains the crop's sensitivity to climate, pests and diseases which may cause big yield variations from year to year, even with good cultural conditions. Here the problem varies according to whether the beans are autumn- or spring-sown. With autumn beans, the losses caused by severe cold, Chocolate Spot disease and birds cannot at present be prevented, although they can usually be alleviated by early and deep sowing and, where the land is deficient in potash and phosphate, by the application of fertilizers. Nevertheless, the crop may fail or form a thin stand which, by encouraging weeds, creates a further problem.

By contrast, spring-sown beans largely escape the hazards of the autumn-sown type, but they have one major disadvantage—susceptibility to Bean aphid or blackfly. When blackfly migrate from their winter host in May and June, spring beans are still growing, and in this condition they are not only more attractive to aphids, but less able to withstand attack. Late-sown spring beans suffer most severely, although in a bad blackfly year even an early-sown crop may fail, especially if other conditions are inadequate. This occurred in an experiment in 1952 with beans grown in potash-deficient soil. The blackfly population rose to 3,500 per plant on untreated plots which yielded only 1.4 cwt grain per acre, compared with 12.5 cwt per acre on plots where blackfly was controlled. In another experiment in 1954, under good conditions of fertility and rainfall, aphid numbers rose to 2,700 per plant on untreated plots which yielded 16.8 cwt per acre, compared with 35.5 cwt on plots where blackfly was controlled.

Pest control

Recent work at Rothamsted has provided an effective means of blackfly control and this, given good husbandry, should make spring beans a reliable crop. The control measure has been made possible by the development of powerful new chemicals, of which certain systemic insecticides are outstanding. The timing of the spray is important—it must be applied soon after the blackfly reach the crop and before their progeny spread down the stem from the heads of the plants. At this stage the aphids have not multiplied sufficiently to cause appreciable harm. In practice (at any rate for eastern England), the spraying date varies from the end of the first week in June in an early season, to the end of the third week in a late season. The crop at this time is still relatively short, the plant stems are elastic and little mechanical damage is done by tractor and spraying machinery. High volume application (60–100 gal water per acre) is recommended, for it is still uncertain whether low volume application (under 20 gal water per acre) is as good.

Prospects and problems

It is likely that, given good conditions, autumn-sown crops will yield more heavily than spring beans, though work at the National Institute of Agricultural Botany shows that the lower yield is partly offset by the higher protein content of the spring beans. Nevertheless, it is probable that early-sown spring beans, given adequate attention, will yield an average of well over 20 cwt per acre if blackfly is controlled. Such yields make the field bean a more attractive proposition, and its future should certainly be assured when higher-yielding strains are produced. It is to be hoped that the plant breeding and strain evaluation work at the Plant Breeding Institute and National Institute of Agricultural Botany will soon lead to practical advances.

Another problem needing more experimental work is that of weed control. There are as yet no weed-killers as safe or efficient as those used on cereals. DNBP gives good results with winter beans, but it can damage spring beans unless the young plants have been hardened-off by a period of dry, cold weather in spring. A pre-emergence weed-killer can be applied safely and should be ideal for spring beans which are drilled deep and are slow to germinate. How far it can replace mechanical cultivations remains to be shown.

Beans as a farm crop

The yield of spring beans can probably be raised sufficiently to make it a worthwhile crop in its own right, but the crop is useful for other reasons. It enriches the soil with nitrogen, with particular benefit to companion crops—for example, oats yield grain with a higher protein content than when grown in a pure stand, and yields of the mixed stand may also be higher. These points are perhaps of limited importance when compared with the value of beans as a break between cereals in a rotation. Recent work at Rothamsted has shown that when wheat and barley are grown too often on the same land, yields of winter wheat are greatly depressed, typical results being 37, 28 and 19 cwt of grain per acre for three successive winter wheat crops. These serious losses are caused mainly by the soil-borne fungus diseases, Eyespot and Take-all; they can be partially prevented by a one-year break from wheat and barley, but a two-year break is much safer. Crops suitable for the break include beans, potatoes, sugar beet, swedes, ryegrass and oats. Of these, beans and oats have the special advantage that they can be combine-harvested and at no time make heavy demands on labour. In view of the value of beans in this connection, it seems unwise to suggest that the land can better be used by wheat or barley, which already occur too frequently in many farm rotations.

Admittedly, field beans as grown at present are not satisfactory, but the crop should not be condemned before its yield potential has been realized by putting into practice what we know about growing it, particularly considering the improvements made possible by recent research.

The Risk of Spray Drift

C. J. EDWARDS

Fisons Pest Control Ltd.

The risk of damage by spray drift to man, animals and crops can be minimized by operational care.

APART from the waste of chemical, spray drift is generally of no significance when the chemical being applied is harmless to man, animals and crops. But if the chemical is harmful, drift can be a very serious matter to your neighbour and yourself.

Spray drift can be divided into three main types:

1. *Direct drift*—the movement of small spray particles outside the target area during the actual spraying operation.
2. *Vapour drift*—occurs after spraying has finished. It is caused after volatile chemicals have been applied and is therefore most severe in warm weather.
3. *"Blow-off"*—also occurs after spraying where a suspension has been used. It is caused by strong winds, which remove some of the dried particles from the crop or weeds.

Direct drift

By far the most important type in this country is direct drift. To some extent it attends every spraying operation. When a poisonous chemical is being used, there is danger to man and animals on the downwind side of the field during the spraying operation, but there is also the danger to animals that eat foliage on which spray drift has collected—for example, sodium arsenite, used for potato haulm destruction, may, in windy weather, drift on to nearby pasture and cause sickness or death to animals that later graze there.

In very strong winds, the loss of chemical due to direct drift may be as high as 28 per cent[1], and this would most likely give a less satisfactory control than the full dosage. Also most of the spray would be found on one side of the plants only.

Spray drift from chemicals containing colouring-matter can cause inconvenience—for example, dinitro spray drift can stain clothing.

There may also be damage to susceptible crops from weed-killers. If the weed-killers are of the contact type, the extent of the damage is usually evident within a few days, and it may then be possible to re-sow. But with weed-killers of the hormone type, crop damage may not be noticed for several weeks after spraying and the full extent not realized until many weeks later, perhaps not even until harvest time.

In this country, the crops most susceptible to weed-killer damage are tomatoes, sugar beet, brassicas, vegetables and flowers.

The damage to any particular field by weed-killer drift is proportional to the concentration of the spray in the air mass multiplied by the time of exposure. The time of exposure depends on the speed and length of the spray-laden air mass[2]. A susceptible crop downwind of a large treated field would, therefore, be likely to suffer more damage than if the treated field were small.

Droplet size

Under field conditions, as opposed to laboratory work, the spray nozzles break up the liquid into innumerable droplets of different sizes. The smallest particles thus formed are liable to be carried away as direct drift. By using special apparatus in the laboratory, it is possible to produce a spray which has most of the droplets of the same size; in the field this is not practicable and unfortunately the spray produced by nozzles has a wide range of droplet sizes. Thus, when spraying at 5 gallons per acre at a speed of 4 m.p.h. and 40 lb pressure, some 5 per cent of the volume of chemical is produced in droplets of 60 microns and under, and as much as 18 per cent of the volume is under 100 microns. (A micron equals one-millionth of a metre.)

Naturally the distance which a droplet will travel varies with its size. The smaller ones will drift for quite considerable distances, as can be seen from the following table.

Approximate distances that different size droplets sprayed at 2 feet above ground would drift in winds of 3 m.p.h. and 10 m.p.h.

Droplet size (*microns*)	Wind Speed	
	3 m.p.h.	10 m.p.h.
	ft	*ft*
200	3½	12
100	10	35
60	30	90
30	100	250
15	400	1,000
10	1,000	5,280

Thus over 5 per cent of the volume sprayed could drift at least 90 feet in a 10 m.p.h. wind and 0.4 per cent of the volume could go at least 250 feet. Fortunately, most droplets below 20–30 microns are not deposited as drift, but remain airborne for a long period and eventually disappear[3].

Strong winds usually create good drying conditions and therefore spray droplets produced in such conditions may evaporate before they are deposited. This means that the small droplets produced in windy weather may drift farther than the figures in the table indicate.

A high proportion of small droplets (under 100 microns) is produced by spraying at high pressure and/or by using nozzle discs with an orifice of less than 3/64 inch diameter. Wetting agents can also reduce the droplet sizes under any given set of conditions by as much as 50 per cent[2]. Therefore chemicals containing large amounts of a wetting agent (emulsifiers) will produce finer sprays than those without: for example, ester formulations of hormone weed-killers contain much larger quantities of wetting agent than the sodium, potassium or amine salts, and the sprays from the esters would therefore be much finer.

Vapour drift occurs only when volatile chemicals are used and when warm weather evaporates the chemical from the crop. Some esters of the hormone weed-killers are volatile and likely to give rise to vapour drift, particularly when the temperature rises above 80°F. Not all esters suffer from this drawback, and with the low volatile esters (for example, isopropyl), the chances of vapour drift are insignificant[4].

"Blow-off" occurs only where suspensions have been used and where there are strong winds soon after spraying. A susceptible crop may be upwind of the treated field, but a change of wind could lead to "blow-off" damage. This is very disconcerting to the careful spray operator, but in practice it only happens occasionally after using DNOC weed-killers. Even then, the damage caused is more localized than for other types of spray drift.

Minimizing the risk

The damage from direct spray drift can be minimized or prevented by taking care when using chemicals that can harm man, animals or crops. If spraying is carried out only when there is little or no wind, the damage would be insignificant. However, crops and weeds continue to grow and pests continue to do damage even in windy weather. So spraying often has to be carried out in windy weather, and it is then best to limit spraying to wind speeds of under 10–12 m.p.h. and to choose the calmest part of the day, such as early morning or late evening. The volume of application should be as high as possible, consistent with the biological efficiency and economy of the operation. If possible, the nozzle orifice diameter should not be smaller than 3/64 inch and the pressure should be as low as possible, provided efficient coverage is being obtained. The spray-bar should be set as close as possible to the crop or weed being sprayed, provided satisfactory spray distribution is being given.

Spraying weed-killers near susceptible crops should ideally be carried out before the crops appear above the soil; for example, early spraying of oats at the 1–5 leaf stage will give satisfactory weed control, and most susceptible crops have not emerged when the oats are in that stage. If the susceptible crop has emerged and is on the downwind side, then it might be best to delay spraying until the wind changes direction. In any case it is highly advisable to leave an untreated strip on the downwind edge. This strip could be sprayed later when the wind changes[5]. The width of the strip to be left will depend on many factors, such as the nature of the susceptible crop, the chemical, dosage and volume rate, wind speed, etc.

Vapour drift of hormone weed-killers is generally not serious in this country, except possibly in a warm summer. It can then be reduced to negligible amounts by using low volatile esters, or it can be eliminated entirely by using the sodium, potassium or amine salt formulations.

"Blow-off" can be reduced by using DNOC weed-killers before susceptible crops emerge. After such crops appear above ground, it is best to leave an unsprayed strip near the crop, particularly in windy weather.

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Honey from Heather

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Honey from common ling heather is highly valued for its unique flavour, but its production involves a special technique in bringing the foraging bees to selected moorland sites.

BEEKEEPERS in the British Isles are fortunate in that nectar-producing flora is both extensive and varied. Howes[1] lists altogether several hundred genera and species which may be visited by bees either for nectar or pollen or both, but, on the other hand, as a result of a recent survey of the pollen content of British honeys, Deans[2] suggests that only 19 species can be considered of economic importance in the production of surplus honey.

From the table below it will be seen that the common ling heather (*Calluna vulgaris*) ranks high as a honey-yielding plant, especially in Scotland. Heather honey is unique in character and is highly valued, so that the heather plant is of considerable economic importance to the beekeeper.

Most Useful Nectar-yielding Plants in England compared with Scotland, Ireland and Wales

Based on the Pollen Analysis of 855 samples

Plant	per cent samples in which pollen occurs			
	England	Scotland	Ireland	Wales
Trifolium repens.	91.2	93	100	93
Prunus/Pyrus sp.	77.4	47	76	73.3
Rubus sp.	54.1	45.1	36	79.7
Acer sp.	49.8	36.3	40	67
Castenea sp.	47.4	7.8	8	20
Tilia sp.	49.7	20.6	4	33.3
Brassica sp.	52.5	38.2	32	46.6
Ligustrum sp.	33.8	7.8	20	40
Vicia sp.	33.9	24.6	8	6.7
Trifolium pratense.	31.8	10.8	20	—
Chamaenerion sp.	22.7	34.2	4	40
Cirsium sp.	23.2	25.5	8	40
Campanula sp.	21.0	10.8	4	13.3
Calluna vulgaris	6.8	41.1	20	6.7
Heraelcum type	25.6	18.6	20	13.3
Taraxacum type	25.0	25.5	52	33.3
Centaurea sp.	21.0	13.7	32	13.3
Aesculus sp.	15.9	3.9	—	13.3
Erica sp.	9.3	20.2	4.0	33.3

From the viewpoint of honey production, it is important to realize that many moorland areas offer virtually inexhaustible sources of honey, but because the ling heather is a late summer flowering plant and moorland

areas are normally remote, thus necessitating the movement of colonies of bees to the foraging region, the production of ling heather honey presents a variety of problems and demands a special apicultural technique. It is proposed in this article to consider the factors necessary for the successful production of honey from the ling heather.

Locality

In the selection of a suitable locality for heather honey production, attention must be given to (1) the extent of the heather area and age of the plants, (2) the nature of the soil on which the heather is growing, and (3) the accessibility of the actual site chosen for the hives and the available shelter.

Small patches of heather, amounting to a few acres, are of little value to bees, but normally little difficulty presents itself in selecting a really extensive moor. The age of the heather plant is, however, more important than is normally realized. The best yield of honey is obtained from young heather plants, growing to a height of 4 to 8 inches. Old heather which has grown rank and has reached the small shrub stage does not seem to produce nectar in any quantity, and it is only under the most favourable conditions that economic quantities of honey may be obtained from such regions. Ideal conditions are realized on moors that are properly managed for grouse shooting, since in such areas regular, controlled burning of the heather is practised. In this way a yearly succession of young heather plants is produced. For best nectar yield, the heather should be growing on the shallowest of soil, indeed almost on bare rock. Where the plants are growing in a bog or over a considerable depth of peat, the honey-producing potential is lowered. Height above sea level, on the other hand, does not seem to affect nectar secretion in any way, but at lower altitudes the greater range of flora available to the bees frequently results in a "blend" type of honey rather than pure heather honey.

Since hives are normally transported by lorry, van, or car trailer, it is an obvious advantage to have a site that is easy of access so that the carrying of hives over long distances is avoided. A certain amount of shelter for the hives is also desirable, for if they are placed in an exposed position many hours of bee work will be lost and a considerable toll taken of the foraging force. If possible, a site half way up the side of an east-west running valley should be chosen, since this offers both north and south facing slopes and thus extends the duration of the honey flow. Obviously the further the bee has to fly to the nectar source, the less actual work of honey storage will be done, so that it is a *sine qua non* that the hives should be set right in the centre of the heather area, or at any rate in such a position that heather is available within a radius of 1,500 to 2,000 yards.

Equipment

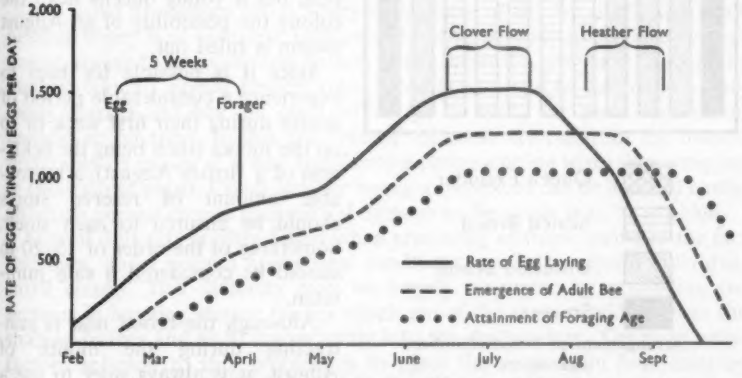
It is true, of course, that the honey-bee colony will function in almost any form of "container", from a straw skep or tea chest, to a hive designed to resemble the most impressive "Grand Hotel"; but clearly, for maximum efficiency in any form of honey production, the equipment used must be simple. For this reason, and particularly in heather honey production, where

in most cases hives have to be transported, the single wall pattern of hive is desirable. Hive design varies considerably, but it is a decided advantage to have the floorboard cut flush with the brood chamber, so that there is no projection at the front of the hive to catch on anything during handling. In addition, it will be found that hives may be packed more easily when they are flush all round. The hive stand should be detachable, again to facilitate stowage and transport. Where hives have to be moved, either in heather work or migratory beekeeping, the self-spacing, so called "Hoffman" type of frame is the most satisfactory in use. These frames, since they can move only vertically and are not displaced laterally, retain their position, even though a hive may be "bumped" in transit. Where metal ends are used for frame spacing, lateral movement of the frames is possible; this can, on occasion, cause loss of bees through crushing or undue excitement, due to the rubbing together, and bruising of honey combs in the brood chamber.

Preparation of colonies of bees for the heather honey flow is best carried out between the middle of July and the end of the month, according to the state of the "local" honey flow. It is sometimes found that a late clover flow or a flow from the lime trees may set back the timetable of heather preparation, but it is important that the heather-honey producing stocks should be on the moors as early in the month of August as possible.

The brood chamber

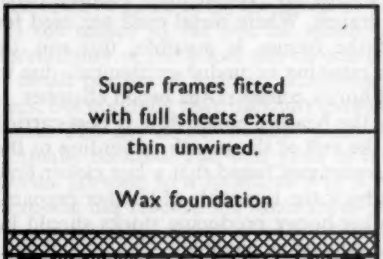
Experience has shown that the heather honey flow is of short duration; at the most, it lasts intensively for 10 days but often only for 5 days. Consequently, if the maximum amount of surplus honey is to be harvested, the colony must necessarily be strong in foraging bees. Also, owing to the more severe working conditions experienced by the bees at higher altitudes, there is quite a considerable loss of bee life, so that if this effect is to be offset the



Colony development for clover and heather honey flow

colony must also contain a considerable potential of new bees in the form of brood. The age of the queen has a direct bearing on this point, since, with any fertile queen over the age of two years, there is a marked decrease in egg production from the end of July onwards. The graph shows the rela-

tionship of egg production to availability of foraging bees for both the clover and heather honey flow. Colonies containing old queens, therefore, may produce quite an amount of honey, but owing to the natural contraction of the brood nest in early autumn, an excess of honey will be stored in the brood chamber. Excess heather honey in the brood chamber, together with limited brood production during August and September frequently results in unsatisfactory wintering of colonies which have been used for heather honey production. This difficulty may be avoided if some care is given to detail in the preparation of the colony.



Queen Excluder

Sealed Brood

Unsealed Brood

Stores

Arrangement of brood chambers and supers

If possible, the queen should be of the current year (introduced to the colony about mid-July or so) but certainly not more than two "laying" years old. If necessary, the combs in the brood chamber should be rearranged so that in the centre are placed the combs containing sealed brood and on the flanks the combs of unsealed brood, while at either extremity the combs of reserve stores. Normally, the colony should be limited to one brood chamber for heather work, but if two (for example, a deep plus a shallow) are used, the above noted comb arrangement still applies. Necessarily, there is a certain amount of constriction of the colony for heather honey production, but if young queens head the colony the possibility of an August swarm is ruled out.

Since it is possible for bees to experience a considerable period of dearth during their first week or so on the moors (such being the fickleness of a British August), a reasonable amount of reserve stores should be ensured to each stock. Something of the order of 15–20 lb should be considered a safe minimum.

Although the brood nest is contracting during the month of August, it is always safer to use a queen exluder to confine the queen to the brood area of the hive. There is no reliable evidence to suggest that the use of the excluder results in any loss of honey.

Each colony should be provided with two honey supers if shallows are used, or one deep if deeps are favoured. If necessary, additional storage

space can be given later, but initial restriction is necessary to induce comb building. The spacing of the combs in the supers is not critical, and where the bees build their combs from wax foundation, adjustment of spacing as comb building proceeds has been found to be unnecessary.

Honey production and extraction

The physical nature of heather honey is such that it cannot be extracted from the comb. Thus the heather honeycomb must either be (a) "pressed" and the honey subsequently run into jars, (b) scraped to the "mid-rib" of the comb and the resulting "mash" of honey pressed, or (c) consumed as comb honey.

For pressing, the surplus honey can be produced either in deep or shallow combs. Such combs should be built from "foundation" each time, since new or "virgin" comb may be pressed much more efficiently than "old" comb. The foundation used should be of the extra thin, unwired type. The pressing of heather honey is, necessarily, a slow process, but the work may be lightened if a large pattern of press is used. The best material to use for wrapping the honeycomb prior to pressing is linen "scrim" cloth. This is much easier to work with than muslin and will withstand a much greater degree of wear. The honey tray of the press should have a large honey gate (diameter at least 2 inches) to facilitate bottling.

Some beekeepers employ the practice of scraping the honeycomb to the mid-rib and subsequently pressing the "scrapings". This method, while saving the cost of new foundation each year, is slow and the "extraction" rate of honey is reduced. An efficient honey press will give an extraction rate of approximately 96 per cent, leaving only the thinnest of wax wafers in the scrim cloth. This wax can, of course, subsequently be rendered or melted and traded for new foundation.

It is usual to produce comb honey in the form of the "section", and much heather honey is so obtained. However, it is also possible to produce heather honey, owing to its gelatinous nature, in the form of a cut comb. This is the method which I myself favour, since it has been found to command a very ready market and has the great advantage of being the most economical method so far tried. In this, the "pieces" of comb are cut from the frames, preferably by means of a wire (similar to a cheese-cutting wire) then wrapped in transparent paper. Comb heather honey so produced can be handled easily, although normal care is necessary if damage to the comb is to be avoided.

Special difficulty is often found when producing sections, owing to the fact that bees, under normal honey flow conditions, are loth to build individual small combs. This difficulty may be largely overcome by producing the sections in hanging section frames which are of the same outside size as the shallow frames and so fit conveniently into the shallow box. The most satisfactory solution to this problem is to place the sections in four hanging section frames in the centre of the shallow box and flank them by shallow frames to complete the comb space. The creation of a "funnel" effect in the centre of the honey storage area is conducive to comb building in the warm air current thus produced.

Another advantage is that the wood of the sections produced in hanging section frames is kept clean, an important point in marketing.

Mention must also be made of a method of "extracting" heather honey by means of a so-called honey loosener. Heather honey possesses the property of thixotropy—that is, it is normally in the nature of a gel which will not flow, but if stirred or agitated in any way the gel becomes sufficiently liquid to allow it to flow. The honey loosener consists of a "brush" of steel needles which may be pushed up and down in the comb, thus causing the gel to become temporarily viscous.

The uncapped combs are then extracted in the normal way in the honey extractor. Under the best conditions, and when using a tangential extractor, heather honey does extract, but if good quality honey is being handled it is normally possible to remove not more than 80 per cent, a value which personally I consider to be too low.

Transporting the colonies

When moving colonies of bees it is important to ensure that (a) the hive parts are secure and that no bees can escape, and (b) the bees have adequate ventilation. The various hive parts in the single wall equipment may be securely fastened by the use of crate staples, and this method is preferred above all others (often more elaborate), as it is simple and inexpensive. A crowded colony of bees may suffocate very easily, so that some thought must be given to the question of providing adequate ventilation. Special measures, however, are necessary only when the bees are to be confined during the hottest part of the day. But the door of the hive must be kept dark at all times during transit, and ventilation, if necessary, provided from the top by means of a screen-board of perforated zinc. Bees are best moved in the early morning, a start being made early enough (according to the distance to be travelled) to allow the bees to be liberated by 9 or 10 a.m. at the latest. My own practice is to close the bees in sometime around 11 p.m. to midnight and load up and move off next morning around seven o'clock. This allows about two hours to travel the 30 miles to the heather site, set down the hives and liberate the bees, before 9 a.m. When such an arrangement is possible no special measures regarding ventilation have been found to be necessary.

Setting down and liberating the bees

It is recommended that all hives' stands should be placed in position and the hives set down *before* any bees are liberated, thus avoiding unnecessary excitement—this time, of the beekeeper! Under normal circumstances there is always a considerable amount of drifting of bees in the apiary, and to minimize this the hives should be set at least 3 feet apart or in groups of three or four, allowing some 5–10 feet between each group. There is always a tendency to place hives in a long row on the heather stance, but this should be avoided, since it leads to excessive drifting. The opening of the hive door should be synchronized with a good puff of smoke from the smoker, thus avoiding an angry rush of bees from the entrance.

Once set down, the hives require little attention during the month, but if weather conditions are favourable provision for additional storage space must be provided. As a rule there is little the bees can harvest from the heather after the end of the first week of September, and any time thereafter

the stocks may be safely brought back to the home apiary, the honey removed in accordance with the normal technique and processed according to the method favoured.

The nature of ling heather honey

The chief value of heather honey lies in its unique flavour and the fact that, unlike other honey types, it is gelatinous and does not flow. It is curious, however, that when *freshly* gathered and stored, ling honey is very "watery" and, if a comb is held horizontally, the honey will run out just like water.

The "goodness" of heather honey may be assessed by the fact of its being gelatinous, so that a piece of honeycomb may be cut without any movement of honey occurring. Heather honey in the jar may be judged for quality by the size of air bubble it contains. These air bubbles are introduced in the process of pressing and, owing to the extreme viscosity of the honey, remain trapped. The larger the air bubble the better the quality of the honey. In spite of its gelatinous nature, heather honey normally contains water to the extent of 22–23 per cent and sometimes more, which probably accounts for the tendency of this honey to ferment.

It is often stated that heather honey does not granulate, but there is little reliable evidence to support this view. It is true, however, that where a really pure sample of ling honey has been obtained, granulation is slow, sometimes taking as long as two years to commence. Such crystallization is characterized by excessively large crystals, which sometimes attain the size of small peas.

The purity of heather honey may also be assessed by means of a technique known as the pollen analysis of honey. An admixture of nectar from other honey plants may easily be detected and an accurate estimate of the purity or otherwise of the honey made.

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The Bee Research Association have recently published a report by Mr. A. S. C. Deans, *Survey of British Honey Sources*. Copies are obtainable from the Hon. Publications Secretary of the Association at Ashcroft, Ongar, Essex, price 2*s*. inc. postage.

Control of the Common Rush

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Spraying with 2,4-D and MCPA has proved an efficient means of eradicating the common rush, but it is important that it should be done at the right time and that the pasture should be carefully managed both before and after.

A TRAVELLER through the upland areas of England and Wales cannot fail to be impressed by the very widespread distribution of the common rush. Its coarse, tufted growth may be seen on the roadsides and in the fields, overshadowing other species and restricting the grazing on holdings where keep is always scarce. Some idea of the size of this agricultural problem has been obtained from a recent survey based on the opinions of N.A.A.S. advisory officers in Yorkshire, Lancashire, Wales and the south-western counties. It appears that in these areas over 200,000 acres of land are infested. Although widespread, the rush is not a new weed in pastures: much is known about its habit of growth, and cultural methods of control have been investigated and reported in past years. However, recent developments in chemical methods of control have created a need for an up-to-date summary of information on the plant and its eradication by chemical means.

Clumps, seeds and seedlings

The common rush (*Juncus effusus*), a perennial plant with a clumped habit of growth, becomes established in wet meadows, on moors and in other places covering a wide range of different soils. It is found most frequently on base-deficient mineral soils, and on peat which is thin enough to allow the roots to reach the mineral layers below. The plant does not grow well on land that is waterlogged throughout the year, nor can it thrive on soils that dry out in summer. Although usually found in open situations, rushes flourish in partial shade, or even in the damper parts of woods[1]. Under agricultural conditions, drainage and fertility are the two important factors that influence the growth of a rush population. The common rush is most often a troublesome weed under conditions of high rainfall and low fertility[2].

When left undisturbed, established plants grow, in clumps, up to four feet high in lowland areas, but more usually to about two feet high in hill pastures. Mowing or heavy trampling tends to alter the clumps to a more uniform spread of individual shoots growing out of the sward. Flowering is in June, July or August, according to the climate of the area. Seed production is abundant, and it has been calculated that on an average piece of rush land up to eight million seeds per square yard can be produced in a single season[3]. The seed is unlikely to be dispersed by wind more than eight feet from the parent plant[4]; and any greater distance must be by the agency of animals,

birds, machines, dung or flood-water. The first three carriers are not likely to cause mass movement of seeds from one field to another, but the last two can be important. The use of mown rushes for stock bedding in winter facilitates the dispersal of rush seed when dung is spread later. Surface water may cause local movement of seeds down hillsides, and river flood-water can carry seed over long distances, causing rush infestations in flood meadows.

After ripening and shedding, the seeds will lie dormant until the following April[5], or they may pass into the soil where they can remain viable for up to sixty years[8]! Germination cannot take place until a number of environmental conditions have been satisfied, the most important of these being moisture and light[5]. Moisture is often abundant and light is most commonly provided in established pastures by poaching or ploughing, which destroys the canopy of herbage and allows light to reach the seed. As there is often much more seed buried in the soil than would be expected from the number of rush plants growing in the sward, fields containing even a few plants can, after ploughing, become badly infested with seedlings. For example, three fields inspected in 1955, two years after reseeding, were found to contain 300–500 young rush shoots per square yard[6]. When young, the plants are delicate and may be killed by drying out, shading or mechanical injury, but once past the seedling stage they quickly become more resistant to adverse conditions and the foundation of an infestation of established plants will have been laid.

Mechanical methods of control

Before the introduction of chemical methods of control, the two most common ways of eradicating rush were mowing (a cheap remedial operation lasting several years) and ploughing, which can be a quick but costly way of removing an infestation. The success of both methods depends largely on the attention given to the right type of cultivation and after-management. Mowing should be carried out between July and September, when a single cut can produce a 30 per cent reduction in shoot numbers and two cuts in two consecutive years an 80 per cent reduction[2]. During the control period and afterwards, fertilizer top dressings and hard but controlled grazing should encourage the grasses and clovers to grow into the clumps and compete more effectively.

Ploughing and reseeding will not be possible on some infested sites, but on the drier, more level land, this may be the quickest way of increasing the productivity of a field. Ploughing should be in spring or early summer and aim at complete inversion of the furrow slice and the burial of rush plants 6–8 inches deep. To achieve this, it may be necessary to mow or disc before ploughing. One of the drawbacks of ploughing rush-infested pasture is the difficulty of making sure of the destruction of the old root systems. Where insufficient inversion or poor compaction of the furrow slice is obtained, the old rushes grow up and appear in the young sward. If the rhizomes are dragged up during seedbed preparations, they must be fully exposed to sun and wind for a fortnight to ensure death: partial burial can make their survival likely[7]. Recommended seeds mixtures (details of which are given in the Ministry's Advisory Leaflet No. 433*) should be sown direct without

* Obtainable free from the Ministry (Publications), Soho Square, London, W.1.

a cover crop but with ample fertilizer dressings to ensure that the young plants form a good ground cover and so compete effectively with rush seedlings. Once reseeding has been done, a policy of higher soil fertility and controlled grazing must be maintained, otherwise the sward will quickly revert to its original state—or it may even be worse.

Chemical methods of control

Since the common rush is a perennial plant, chemical control must be by a herbicide that kills the roots as well as the tops. The plant-growth regulators, 2,4-D and MCPA, have been found to be the most effective chemicals for this purpose. Although the ester formulations are slightly more toxic to the rushes than the potassium or amine formulations, they are also more toxic to the grasses and clovers, and are usually considered less selective. In common with most other plants, young rushes are more easily killed by 2,4-D and MCPA than are established plants.

The chemical methods of rush eradication can conveniently be split into three distinct approaches. The first is the destruction of established plants before ploughing and reseeding; the second is the selective control of young rush plants in newly-sown pastures; and the third is the selective control of rush in established pastures.

An important part of the reseeding of rush-infested pasture is, as has been explained, the killing of the root systems before ploughing. For this purpose, 2,4-D (ester) at 16–24 oz per acre would appear to be the most worthwhile chemical; at equivalent rates it is more toxic to rushes than MCPA (potassium) and 2,4-D (amine), and in consequence it may be cheaper. Its greater depressive effect on other species in the sward is unimportant when ploughing follows shortly after. No experimentation on 2,4-D (ester) for this particular purpose has been reported, but a trial has been carried out in Devon, in which MCPA (sodium) and 2,4-D (amine) at 16 oz and 24 oz per acre were applied to established rush and followed by ploughing at three and six weeks later. After direct reseeding very few rushes appeared in the young sward, and after four years the sprayed areas were still exceptionally clear of rushes, although in the unsprayed parts of the field the rushes were growing vigorously[8]. The killing of established rushes before ploughing overcomes the danger that the reseeding may be wasted by early re-growth in the young sward; also it permits greater flexibility in cultivations which would otherwise have to be planned primarily to prevent such an occurrence.

Having dealt with the problem of old-established plants, consideration must be given to the second important danger to reseeded pastures—the seed lying dormant in the soil. Rush seedlings will start to emerge after sowing and will continue to do so until the new sward provides a full ground cover—either in the first or second year, according to the growing and management conditions. During this period, the young rush plants will not compete seriously with the grasses and clovers. Once the ground cover is sufficient to prevent further germination, and the clovers are well-established, the rushes may be killed by spraying. In three experiments put down in 1954 on young pastures in the North of England, 16 oz per acre of 2,4-D (amine), or MCPA (sodium), was applied in early July of the year following that of sowing, and produced a 97 per cent reduction in the numbers of rush shoots

recorded a year later[8]. Unfortunately, 2,4-D and MCPA have a depressive effect on the clovers and, as yet, only preliminary experimental work has been done to test MCPB and 2,4-DB. But the results so far suggest that these new chemicals, with their low toxicity to clovers, may be extremely useful for controlling rush seedlings in reseeded pastures[9].

The third method of eradicating rushes is by the selective control of established plants in pasture. This operation was the subject of many investigations between 1950 and 1955, and the results have been consolidated into the following recommendations given in the *British Weed Control Handbook*, 1957:

> The spraying of *Juncus effusus* should take place before flowering when the rushes are growing vigorously. It is strongly recommended that the rushes are cut about four weeks after treatment. This not only provides the kill, but helps the sward to develop over the dead rush clumps. If desired, cutting may take place a month before spraying with equally good results, but if this is done, the cut litter must be removed before spraying. Spraying uncut rush can give good results, particularly when the rushes have been cut in previous years. Higher doses than those given below may be required for a complete kill. Cutting immediately before spraying is not recommended.
>
> Recommended rates of application:
>
> MCPA or 2,4-D (amine)...32 oz per acre
> 2,4-D (ester) ...16–24 oz per acre

Management also plays its part

While in many situations an excellent control of rushes can be obtained by carrying out the recommended treatments, no economic dose of 2,4-D or MCPA can guarantee a complete kill under all circumstances. It is apparent from the variability of the experimental results that rush populations differ considerably in the ease with which they can be killed. The success of the operation depends largely on the management of the field both before and after spraying; in experimental work, the best results were obtained on fields in which pasture management was encouraging the improvement of the more productive species[10]. In vigorous swards, the dying rush clumps are quickly colonized by the surrounding herbage, but on fields in which the productive species are making little growth, the death of the clumps leaves open patches in which rush re-invasion can occur.

Although cutting greatly assists the action of the chemical, it may be difficult and costly on steep or uneven ground. In New Zealand, an alternative method used on land that does not easily poach is to stock the ground very heavily for a short time two months before spraying and thereby tread and tear the rush clumps[11]. Harrowing has not been tried out experimentally, but it might be a worthwhile alternative on land that cannot be mown.

The common rush is only one of the three species usually encountered on farms in the British Isles; the other two are the hard rush (*J. inflexus*) and the heath rush (*J. squarrosus*), neither of which can be chemically controlled. Chemical or mechanical eradication of the common rush cannot directly alter the soil or management conditions that were responsible in the first place for the presence of the weed. The act of removing rushes will, in itself, increase the productivity of a field, but when accompanied by other measures to encourage the grasses and clovers, it can produce an even larger yield of herbage, and long-term control may be ensured.

Financial assistance in the chemical and mechanical control of common rush can be obtained from the local County Agricultural Executive Committee as a Livestock Rearing Land Improvement Grant, or under the Marginal Production Scheme, provided the control is part of a general scheme for improving the field and is agreed with the Committee before work starts.

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Fertilizer Practice in Hill Areas

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The views expressed in this article are based on experience gained during experimental and advisory work in the hill areas of the North of England.

In so highly an industrialized country as Great Britain it is not surprising that the economic value of the hill country has tended in the past to be underestimated, but the gross output of this land in terms of milk, meat and wool proves that these upland grazings are a national asset. Upland areas in Scotland constitute approximately 70 per cent of the country, or 10.7 million acres of actual upland grazing, compared with the 12.1 per cent or 4.5 million acres in England and Wales. Of the total 15 million acres of upland grazing, approximately 5 million are marginal and 3¼ million are capable of material improvement.

The classification of farming units presents difficulties, particularly in

England and Wales, where the association of lowland and hill farming is closer, and the transition more gradual than in Scotland. The enterprises fall into three main categories: (1) genuine hill farms with some cattle but sheep predominating; (2) marginal farms with cattle and sheep under a livestock rearing system, although in some cases the animals are fattened, and on some of the lower farms cash cropping (mainly seed potatoes and cereals) is encountered; and (3) upland milk farms. Grassland farming is the foundation of all these systems. How intensively the land is managed depends upon the farming enterprise, but equally on the managerial ability of the farmer.

Upland soils

Compared with the soils of the lowlands, the upland soils (which are very variable) are handicapped by development on poor parent material, a rigorous climate, often accompanied by an excessive rainfall, and neglect due to past economic difficulties or indifferent management. Site disadvantages can, however, be counterbalanced by drainage, fertilizer applications and intelligent management.

Satisfactory drainage is essential if maximum return is to be obtained from the fertilizer input. In the remainder of this article it will be implied that drainage is adequate. The other main factors requiring rectification are low lime and phosphorus levels.

Periodic liming is necessary to offset the impoverishment caused by leaching and losses in the herbage and animal products removed from the farm. Soil analysis will provide an adequate assessment of the lime requirement. Provided equivalent quantities are applied and spreading is efficient, the type of liming material used is not important; the aim should be to obtain the cheapest spread per acre for equivalent amounts. Where hypomagnesaemia is troublesome, magnesium limestone materials could be useful if they can be obtained cheaply enough.

In the higher rainfall regions of the west, experiments[1] have shown that frequent light dressings of lime give the most efficient utilization on the lighter-textured soils, provided haulage and spreading costs are not excessive. On heavy-textured soils and in other regions, more substantial applications could be given at longer intervals.

Phosphorus

For maximum productivity in upland areas, the soil's phosphorus needs must be satisfied. As the spring is generally cold and late, an adequate soil phosphorus status is particularly important for promoting earliness in grass. Where the "available" phosphorus level is low, four to five years of regular, economic fertilizer dressings will be required to raise it to an adequate level. Placement effects of the individual fertilizer applications during this period of improvement will provide the associated crops with sufficient phosphorus for profitable yields. Following this build-up, maintenance fertilizer applications, depending on the crop, will be necessary.

A list of the principal phosphatic fertilizers with typical analyses and certain recommendations is given in the following table.

Phosphatic Fertilizers

Typical Analyses

	Total P_2O_5	Water soluble P_2O_5	Citric soluble P_2O_5	Effect	Crops for which they can be used
	per cent	*per cent*	*per cent*		
Superphosphate	18	90.0	91.0	Efficient on all soils except the very acid	All crops
Triple Superphosphate	47	83.0	85.0	As above	All crops
Basic Slags:					
Higher grades					
(i) 16% grade high soluble	16	—	90.0	Efficient on all soils, particularly where slightly acid.	All crops but mainly for grassland, roots and kale.
(ii) 12% grade high soluble	12	—	88.0		
Lower grades					
(i) 12% grade medium soluble	12	—	57.0	Efficiency as a phosphatic fertilizer decreases as citric soluble P_2O_5 per cent decreases. Should be used on slightly acid soils	Mainly grassland
(ii) 12% grade low soluble	12	—	25.0		
(iii) 9% grade low soluble	9	—	40.0		
North African Mineral Phosphate	29	—	39.0	Efficient on lighter-textured soils and peats which are slightly acid	Can be used on *established* grassland, swedes, turnips, kale, pioneer crops based on rape

The citric soluble P_2O_5 percentage is the most reliable index of the efficiency of a basic slag, and it is important that this value should be as high as possible. Basic slags (and mineral phosphates) also have some liming value—one cwt approximating to one cwt of ground limestone.

The efficiency of phosphatic fertilizers can vary according to the crop and soil type. Superphosphate can be used for all crops and is particularly useful on heavy, cold soils in upland districts; on acid soils, however, it has some limitations. Basic slags suit most crops but are mainly utilized on root crops and grassland, and slightly acid soils. High citric-soluble slags approximately equal superphosphate in efficiency, but low soluble slags are much inferior. Mineral phosphates are useful in certain situations, especially in the milder western regions. In upland districts, moisture is rarely a limiting factor and experimental evidence[2] points to soil temperature as the other main factor controlling the efficiency of phosphates. Consequently, on the lighter-textured upland soils, mineral phosphate could be used for established grassland, root crops and pioneer crops based on rape.

Phosphatic fertilizers should be applied on the "little and often" principle, whenever possible. On very deficient soils, dressings of 4.5 cwt per acre of superphosphate or high grade basic slag, or 6.5 cwt per acre of mineral

phosphate are necessary for grassland, roots and pioneer crops. The dressings can be reduced to maintenance applications as the phosphorus status improves. As a rough guide for estimating maintenance dressings, 1 cwt of 18 per cent superphosphate (or its equivalent) should be applied for every ton of dry matter removed.

Potash

Except on light soils, potash levels are usually satisfactory in upland grazing areas, and no potassic fertilizer should be applied unless soil analysis reveals a deficiency. If potash depletion occurs through frequent cutting for hay or silage, a dressing of 2 cwt per acre (60 per cent) muriate of potash should rectify it. Maintenance applications based on 1 cwt (60 per cent) muriate of potash for every ton of dry matter removed will be required.

Upland meadows, traditionally managed, develop a "herby" sward, due primarily to overgrazing and a low potash level. Potash applications alone can significantly alter the vigour and percentage of the grass species, but further modifications can be effected by controlled utilization and nitrogenous fertilizers. On some dales farms where meadows have been intensively managed for silage over a period of five years, the grass-herb ratio has improved and yet the basic "herby" nature remains. Two or three silage cuts are taken annually with dressings of 2–3 cwt per acre of sulphate of ammonia per cut, plus basal dressings of phosphate and potash.

Farmyard manure is a by-product on upland farms; it should be applied to the meadows and any appropriate arable crop. It is not a complete fertilizer and needs to be supplemented, particularly by nitrogen, according to the crop. The function of farmyard manure is the long-term maintenance of soil fertility.

Inbye land and outer grazings

Maximum conservation of grassland products for winter feeding must be obtained from the inbye fields. Stock-proof walls or fences, adequate fertilizer applications and efficient conservation methods will ensure that this aim is achieved.

Traditional management usually maintains the lime and phosphorus status of these soils, but should deficiencies exist, they must be rectified. On this foundation nitrogenous, phosphatic and potassic fertilizers can be applied to produce the winter feeding requirements. Grass production and utilization of each field should be planned before any fertilizer is distributed, and conservation, as silage and some tripod hay, must be considered. Then dressings of up to 3 cwt per acre of sulphate of ammonia for each silage crop could be given, with advantage. Assuming the silage is well made and fermentation losses normal, yields would probably be 7–8 tons per acre. For the hay crop, 2 cwt sulphate of ammonia would be sufficient and yields of about 40 cwt per acre could be expected.

Budgeting for winter needs is therefore possible. The approximate winter feeding period is known, and assuming a daily ration of 12–14 lb hay or 42–56 lb silage (or a combination of these per cow equivalent), a fertilizer

programme could be formulated to meet the farm's needs. The contingency of an abnormally hard winter must be allowed for.

The intensive management of the inbye fields for conservation purposes will place strains on pasture resources at certain times of the year. Simultaneously, therefore, an improvement programme for the outer grazings must be planned. On the majority of farms this will involve the upgrading of existing or neglected enclosed land, but the reclamation of fell grazings may have to be considered.

Attention to walls, fences and drainage is a prerequisite to the build-up of the soil nutritional status. Lime and phosphatic fertilizers are the key to a permanent increase in productivity. Only occasionally is potash deficient. In these upland pastures reliance on clover to supply the nitrogen requirement gives the most satisfactory return: for instance, on one farm in south-west Northumberland a permanent pasture, situated at 1,100 feet, is capable of *fattening* a beast to the acre in the productive season. Regular dressings of basic slag or mineral phosphate every third year have maintained a magnificent grass-clover sward. It was calculated that over the last thirty years every acre has received 75 cwt of some phosphatic fertilizer, equivalent to an annual dressing of 2½ cwt per acre. This pasture grazes early and provides keep late into the autumn; in fact, as with all well-managed feeding pastures, the field is stocked according to the state of the sward. Needless to say, the farmer is well satisfied with the return on this input.

Ploughing and reseeding could effect improvement in appropriate cases, but before reseeding, pioneer cropping should be undertaken to build up the soil fertility. Pioneer crops based on rape can profitably be utilized for fat lamb production; one acre of good rape should fatten ten to sixteen cast ewes, wethers or lambs[3]. After dressings of lime, phosphate and potash, rape can be given 3 cwt per acre sulphate of ammonia to provide a high protein feed.

The reclamation of fell grazings could be by surface treatment or ploughing and reseeding. The method used will depend upon the kind of soil, accessibility, general farm requirements and the capital involved.

Fell grazings

Fell grazings have an important role to play in the general productivity of hill farms. Direct fertilizer applications are not possible, because of inaccessibility, but experiments with small dressings of lime and superphosphate (equivalent to those which could be delivered from aircraft) are in progress. Interim reports indicate that single dressings have no effect on sward composition, but plant uptake of calcium and phosphorus increases and this is attractive to stock. The effect of this treatment lasts approximately three years. Should economic considerations permit, aerial application (as in New Zealand) could have a profound influence on the future stock-carrying capacity of our fells.

Switches of hill stock from fell to improved inbye fields can precipitate physiological disturbances, such as hypomagnesaemia. It is advisable to have some "transition" land between the fell and the inbye fields to eliminate violent change and condition the stock. It may be that as a direct consequence of increased fertilizer use two sheep flocks will develop; the tradi-

Marginal country near Weardale, Co. Durham.

Hill country near Alston, Cumberland. In such areas, crop production from certain fields becomes very difficult.

Photos: *W. Tempest*

Education through Farming (Article on pp. 80–2)

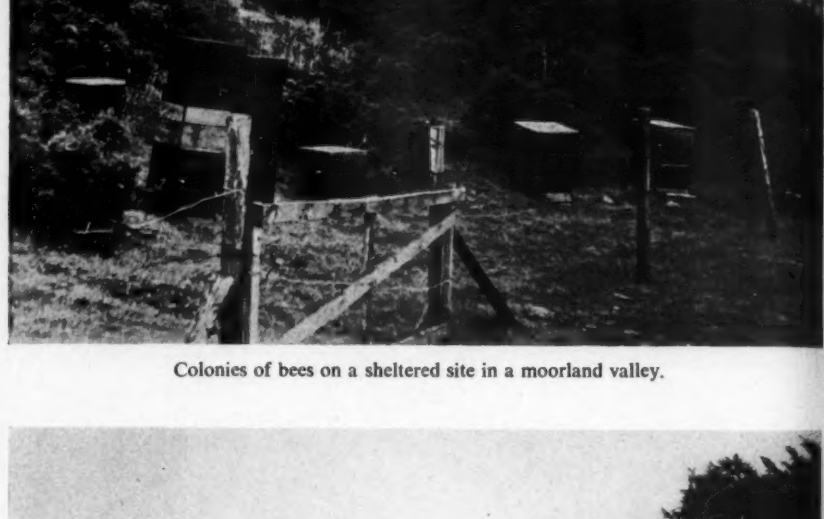
In the dairy.

Opposite: The team that built the trailer.

A pig-weigher, also made by the boys.

Honey from Heather (Article on pp. 63–9)

Colonies of bees on a sheltered site in a moorland valley.



Photos: *A. S. C. Deans*

Typical well-managed moorland where a succession of young heather plants is always found.

tional hill flock managed as such, and an improved inbye flock to utilize the richer pastures.

Upland milk farms

The techniques of grassland management for milk production have already been evolved and should be applied to upland conditions. Soil requirements in respect of lime, phosphate and potash are precisely the same as for other hill farms. As a policy decision, however, the nitrogen requirement should be met by using fertilizer nitrogen instead of relying on the nitrogen fixed by clover.

Maximum utilization from grassland resources must be the aim. A sound fertilizer programme, together with conservation for winter use and control of grazing by modern techniques, will accomplish this. Wherever possible, ploughing and the sowing of leys or grass mixtures for definite production purposes should be undertaken: for example, Italian ryegrass for the early bite and timothy–meadow fescue mixtures. If this is impracticable on an extensive scale, adequate manuring and sensible management of existing swards can go a long way to meet production needs.

Nitrogenous fertilizers should be applied generously to give controlled production, remembering always the need for basal dressings of phosphate and potash. Three cwt per acre sulphate of ammonia would be adequate for each silage cut and 2 cwt per acre for a hay crop. For each grazing, 2 cwt per acre sulphate of ammonia can be given and the young growth grazed, using an electric fence.

Kale can be a useful crop at the back-end, and the introduction of a few acres each year should be considered[4]. Basal dressings of phosphate and potash, together with 2 cwt per acre sulphate of ammonia, should be worked into the seedbed and a 2 cwt per acre "Nitro-Chalk" top dressing applied later to give a high protein feed.

Fertilizer use and management

There could be no more fruitful field for the integration of modern fertilizer techniques than on the hill farms of the United Kingdom. An extension of this kind could be of immense benefit to hill farming, and for the farmer with the right outlook the incentive is there. Fertilizer usage is controlled by farm policy, but, broadly speaking, sound fertilizer practice and intelligent, all-round management could achieve the following:

Hill and marginal farms

(a) the maximum production from grassland resources to decrease the farmer's vulnerability to hard winters, and eventually allow home wintering; (b) an improvement in the stock through reduced mortality, increased numbers and higher quality and (c) where feasible, reduce the dependence on store market fluctuations, particularly with lambs, by fattening all or some of the stock.

Upland milk farms

by the intensive management of grassland, obtain maximum production from home resources in an endeavour to reduce production costs.

In this broad survey, ways in which the use of fertilizers could be integrated into hill farming systems have been outlined, but there is no detailed discussion of another important factor—the human element. To provide

that additional incentive and attract men of the right calibre and outlook, an associated development of social amenities for their families is indispensable.

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Education through Farming

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A new approach to general education by teaching through farming has been made at this school. Many education authorities, including some from overseas, have studied the system and commended its value for the rural child.

CLYRO Court Secondary School was opened in 1947 to give a sound general education with an agricultural bias. It is situated in the Wye Valley and draws most of its pupils from the foothills of the Radnor Forest, a wholly agricultural area of small family farms concerned mainly with stock rearing. The children have a common fund of knowledge of agriculture and the countryside, an interest in adult activities, and a facility in practical work gained through participation in these activities.

To harness their knowledge and interests and provide a practical approach to education, it was decided to introduce some small-scale farming into the school. To this end, a 24-acre smallholding and a small market garden and orchard were developed from derelict parkland. The only building at first available for the housing of stock was a cottager's pigsty, so we had a Dutch barn with a lean-to erected, and to this the pupils added a cattle yard. We started with a flying herd, but soon found that the flying herd system offered too little of educational value, so a change was made to dairying and pig rearing.

From practice to principle

Practical farming as an approach to general education offers many advantages—among them, increasing ability in traditional crafts and the new skills demanded by mechanization, and, of greater value, ease of approach from practical work to the underlying reasons, and from these to basic principles.

It is of great educational importance to recognize that knowledge is obtained by the study of familiar, everyday things, so that its value becomes obvious and direct. Instead of mathematics being merely an academic study, it becomes a handy "tool" when a field is being measured, the growth rate of pigs being graphed, and when conversion ratios, winter rations, deadweights, or profit and loss are being calculated.

The farm forms a starting point for wider studies. Lorry loads of early potatoes passing by when our tubers are beginning to form quickly leads to a comparison with Pembrokeshire and its earlier growing season. Similarly, through the Marketing Board's publications, we can compare local yields with those throughout Great Britain. Physical geography and climate become matters of immediate interest. Links can also be found with the past—potato blight with famine and emigration and subsoil with the Ice Age.

Like their fathers, country children are the more readily convinced of the value of demonstrations and experiments when they see them carried out under field conditions, and in this sense the farm is used as a laboratory. First of all we laid down manurial and variety trials, often in conjunction with the N.A.A.S., but this type of work is now incorporated in the routine farming.

We are constantly meeting real problems, and in their analysis and the search for solution the boys are led logically to study in other fields of knowledge and come to realize the integration of one with another. For example, when graphs of the milk yield showed a number of minor fluctuations, a study of the school's records afforded some understanding of the complex inter-relation of weather and plant and animal physiology. In such work the pupils' background knowledge is evaluated and amplified through informal discussion, and (what is supremely important) they are taught to think for themselves.

The opportunities which the smallholding provides for continuous and long-term observations are also of great value. For instance, it is possible to watch the growth of a crop from germination to maturity, to lift, weigh and record at regular intervals, and so learn the processes of plant and animal growth, development, and behaviour more thoroughly than would be possible by the study of text-books. Demonstrations and trials can be repeated or modified year after year, and the results assessed in terms of variable external factors.

Gaining experience

The nature of the benchwork course is strongly influenced by the presence of the smallholding and by the way of life of the community. Even during their preparatory course the pupils do what they can to serve the needs of the farm and the garden; and as their competence increases, so does the amount of estate work which they carry out. In their final year they jointly undertake at least one major project. These have increased in complexity from the making of a cold frame to the manufacture of a pig weigher and stock trailer. The boys are encouraged to make tools for use at home and to bring broken implement parts for repair or renewal. Interest in all this work is intense and the standard of craftsmanship is extremely high. Repairs to tractors and implements are also carried out, although the normal care and

maintenance, and the study of the internal combustion engine, are linked with other subjects.

The Rural Domestic Science course includes dairy work, butter- and cheese-making, bacon-curing and poultry-keeping, and full use is made of the produce of farm, garden and orchard. This provides the girls with an essentially practical approach to general education, and they share with the boys a delight in creative activity.

Aim and achievement

The aim of the school is not to teach farming, but to teach *through* farming. Nine years of experience have brought out the great value to the country-bred child of such an approach. Working at familiar tasks in a familiar environment engenders a feeling of confidence in even the most backward, and new knowledge is more readily acquired when it can be fitted easily into the pattern of the old. It was found, for example, that the value of silage was first grasped through the condition of silage-fed beasts, and that its chemical analysis became relevant only when the beasts were found to fetch top market price.

It should also be understood that the school is concerned not with the needs of the countryside, but of the pupils. Nevertheless, seventy per cent of these pupils, not all farm bred, take to the land. We hear of sound craftsmanship, of increasing mechanization on farms which had lagged in this respect, of the reclamation of derelict land, of increasing production, and of a more ready acceptance of the fruits of scientific research. A small but increasing number are, despite the needs of the family farm, remaining at school beyond the statutory leaving age of fifteen.

Of the remaining thirty per cent, many boys are taking up engineering and a number of girls are going into nursing. Reports show that they are fitting happily and successfully into their new environments.

The school stands at a place where three roads meet—one runs to the uplands, one along the fertile valley with its villages and small market towns, and one down the valley to the plains and cities beyond. It would appear that education through farming and its ancillary activities is playing an important part in equipping these country-bred children to travel any one of these roads with confidence.

Country Industries Exhibition

June 1–15

HOLLAND PARK, LONDON (near KENSINGTON HIGH STREET)

This exhibition has been organized by the Rural Industries Bureau and its aim is to show townspeople the variety of trades carried on in rural areas.

Quaternary Ammonium Compounds

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When the Milk and Dairies Regulations were revised in 1949 and sodium hypochlorite was allowed as an alternative to steam or boiling water for sterilizing farm dairy utensils, provision was made for the approval of any suitable chemical sterilizer. The Ministry is now in the course of granting this approval to certain formulations containing quaternary ammonium compounds (QACs) mixed with detergents.

ALTHOUGH the Milk and Dairies Order (1926) allowed the use of sodium hypochlorite for sterilizing milking machines, little interest was taken in chemical sterilization until 1940. The war stimulated fundamental investigation at the N.I.R.D., and a method was proposed for treating utensils in an emergency with hypochlorite, which was allowed in 1943.

Experience gained with chemical sterilization indicated that the use of hypochlorite should be further investigated in the field before general approval could be given to the material. As a result, field trials carried out by the N.I.R.D., in conjunction with the Ministry's Advisory Bacteriologists, led to more detailed proposals and official recommendations. Still further work on chemical sterilization led to a revision of the official recommendations, and these were embodied in the Ministry's Advisory Leaflet No. 422.

During this time other materials were being considered for use on the farm, and from 1949 to 1954 the N.I.R.D. carried out many field trials on different types of materials, but none of them was found to be as good as sodium hypochlorite. In the early 1950s the Institute made single trials on a few materials, but as the number of materials submitted for approval increased, the co-operation of the Provincial Advisory Bacteriologists and Milk Production Officers was sought.

In subsequent tests all the materials were compared with sodium hypochlorite and used in the manner recommended in Advisory Leaflet 422, but according to the concentration recommended by the manufacturers.

In 1953 and 1954 all materials were subjected to a screening test by the Hoy Can Test, but unless materials were shown to be worthless and likely to lead to rejection milk in the field, they were accepted for field trials. None of the materials passed these tests; many failed because they were not good enough disinfectants, although some failed because they produced undesirable side-effects.

After these trials an important decision was taken by the Ministry to create a committee, on which was represented the British Disinfectant Manufacturers' Association, to advise the Ministry on which materials were worthy of approval.

Recent field trials

The policy for accepting materials for the 1956 field trials was changed, and only materials which compared favourably with hypochlorite in the screening test were accepted for field trials. It was thus anticipated that all the materials accepted for field trials would pass, unless there were any undesirable side-effects or there developed a build-up of micro-organisms resistant to any QAC. In fact, there was no evidence of the existence of resistant micro-organisms during the period of the trials.

Of sixteen materials submitted, ten were accepted for field trials. Forty farms were used for the trials in the Midlands and southern part of the country and in mid- and south Wales. The farms in the Midlands were restricted to a ten-weeks' trial period, 5 weeks for a test material and 5 weeks for the control material (hypochlorite plus an alkaline detergent). Because high average temperatures persist longer in the south, each farm was used for a period of 15 weeks—two five-week periods for test materials and one such period for the control material. This meant that each material tested was used on at least six farms in different parts of the country.

The allocation of the materials to the test farms and the period at which each was used followed a statistical plan designed by Mr. F. B. Leech, of the Statistics Dept. of Rothamsted Experimental Station, who also analysed the results.

Each farm chosen for experiment had a bucket-type milking machine plant, and was visited by the local Milk Production Officer, who, where necessary, instructed the dairy worker in the correct use of chemical sterilization. To test this, the producer was allowed a short trial run on his own, before the trial proper started, to establish that he was proficient in the use of chemical sterilization.

When all was ready for the trial to begin, all the metal utensils were descaled with an acid detergent, new rubber parts provided and all were cleaned and then sterilized by steam.

It is usual with chemical sterilization to use certain safeguards. These are weekly or fortnightly heat treatment of metal and rubber parts and periodic descaling. During the five-week test periods these safeguards were not applied, because an attempt was being made to test the materials to "breaking-point", and to compare the time which the control and test materials took to reach this stage. This point was not reached on every farm, as it depended very largely on the thoroughness with which the materials were used. However, it was the *comparison* between the test and control materials on each farm which mattered, and this was measured by bacteriological tests of the milk from four consecutive evening and morning milkings per week and one set of bacteriological rinses of the utensils per week. At the end of each five-week period all metal utensils were descaled, new rubber provided and everything steam sterilized in readiness for the next test.

It is not possible to go into all the details of the trials here, but virtually every precaution was taken to see that they were fair and unbiased. None of the participants knew the identity of the materials they were using, and the supervision was minimal.

Results

The results of over 3,000 bacteriological tests were analysed statistically and the computation checked by the "electronic brain" at Rothamsted. The standard of performance of nine of the materials (one was withdrawn during the trials) can be judged by the averages of results given in Table 1.

Table 1

Adjusted mean results from bacteriological tests of milk and utensil rinses when QACs and hypochlorite were used on the farms

Material (Code No.)	Milk Samples		Rinse Samples		
	Keeping quality. Hours to clot-on-boiling at 22°C	Colony count per ml on fresh milk	Colony counts per sq. ft on: Strainer and pan	Two machine buckets	Cluster and milk tube
1	46.8	3,300	3,500	800	2,200
2	42.2	4,000	11,500	2,800	8,500
3	46.0	5,000	4,300	600	2,800
4	40.1	3,800	9,600	4,800	5,600
5	43.0	5,600	6,200	1,000	7,600
6	42.4	3,800	4,100	1,100	2,300
7	42.0	6,000	4,700	2,700	8,700
8	42.3	3,200	1,300	600	1,700
9	42.0	4,400	10,700	11,000	11,000
Hypochlorite	43.3	4,000	4,600	1,300	6,200

(Counts are corrected to nearest hundred)

It can be seen that all the results are very close to that given by the control material, sodium hypochlorite, and some are better. Statistically, none of them differ significantly from the control; that is, any differences observed, whether better or worse, are within the experimental error of the test. Furthermore, all the results given in Table 1 are good results. This can be judged from the suggested standards for satisfactory raw milk set out in Table 2.

Table 2

Suggested bacteriological standards for raw milk and utensil rinses

Milk	
Keeping quality (time to clot-on-boiling at 22°C)	39 hrs
Bacterial colony count per ml (3 days at 30°C) on fresh milk	less than 10,000
Rinses	
Bacterial colony count from rinse of one sq. ft of surface (3 days at 30°C)	
Excellent	Less than 10,000
Fair	10,000–50,000
Unsatisfactory	Greater than 50,000

Although all the materials were judged to be satisfactory detergent-sterilizers from a bacteriological point of view, not all were accepted as satisfactory by the users. Some of the materials caused irritation of the skin and others caused the rubber tubes of the milking machines to slip off the machines during use. As a result, four of the materials have been regarded as unsuitable for approval.

The formulation of a detergent-sterilizer for the hand washing of farm dairy utensils is not an easy matter. The sterilizing action of the material must be quick enough to kill bacteria in two minutes, but the defatting action must not be so drastic that the skin of the workers' hands is damaged. Further, the rinsability of the material must be good, so that it does not remain as a film on the rubber parts and cause them to become slippery or sticky during use.

It is important to record that on all forty farms tested no trouble was experienced with sodium hypochlorite plus an alkaline detergent, and all agreed that it was an acceptable mixture for dairy use. Thus the choice of the existing approved material as a control standard was vindicated on all counts, and further proof added (if need be) on the soundness of the approval by the Ministry of sodium hydrochlorite for cleansing dairy utensils.

Experience with screening tests and farm trials over a number of years has shown that a simplification in the method of testing is possible. As the screening test measures the combined effect of disinfection and detergency, this test can be used to evaluate these materials. We are now confident that the cleansing ability of detergent-sterilizers in field trials can be predicted by the can test, thus dispensing with the necessity for such long trials which could only be held in the summer-time. However, the can test is not able to measure physical troubles which the use of the materials may bring about, and to cover this point it is still necessary for short "user trials" to take place to safeguard both the user and the manufacturer against unsatisfactory physical effects.

The present position

Some of the brands of QACs now in the course of approval are mixtures of detergents and disinfectants in a powder form. This should prove a great convenience in some respects, as there will be only one material to measure, and it will be supplied in a non-returnable container. On the other hand, this combination of detergent and disinfectant does rather detract from the versatility of chemical sterilization; the ratio of detergent to disinfectant is fixed, whereas some producers may wish to vary this for such purposes as udder washing and wet storage of clusters. For those who desire a material that is flexible for such different uses, there are QACs in which the disinfectant is a liquid and is sold separately from the special detergent which has been formulated for use with it. All brands will carry the manufacturers' guarantee of the period over which the material will remain active.

These new materials will bear on the label the dosage whereby they were found satisfactory in the trials and subsequently approved. It must be emphasized that these are *minimum requirements* only, and the manufacturers may well recommend a more thorough technique.

The method of testing all materials was the same. In the morning the

utensils were given a preliminary rinse in cold water, and then a hot (110°F) detergent-sterilizer wash at the dosage recommended by the manufacturer (the use dilution). This was followed by a rinse with a solution of quarter-strength use dilution. After the evening milking the utensils were rinsed in cold water and given a "brush-rinse" in a cold half-strength use dilution.

The normal safeguards which apply to chemical sterilization by approved hypochlorite, as given in Advisory Leaflet 422, will obtain here. These are a weekly heat treatment of metal utensils, weekly or fortnightly hot detergent soak of rubber parts, and periodic descaling to remove milkstone or water hardness with a suitable acid detergent. *Chemical sterilization by hand washing with any material cannot be carried out satisfactorily without these safeguards.*

Water sterilization

The QACs have not been required to be good water sterilizers to obtain approval, although some of them are. With a mains water supply of good bacteriological quality, the QACs may be used satisfactorily in the final rinse water. However, with waters in which there is slight bacterial contamination—or those supplies which are undergoing improvement, hypochlorite *must* be used in the final rinse water in the morning and evening (at least 1 oz per 10 gallons of water). The N.A.A.S. Milk Production Officers can, of course, advise on all aspects of chemical sterilization.

Grateful acknowledgment is made to farmers and their staffs and to the Provincial Advisory Bacteriologists and Milk Production Officers of the N.A.A.S., and also to N.M.T.S. staff who assisted in the trials.

Reference must also be made to Mr. F. B. Leech of the Statistics Department, Rothamsted Experimental Station, and to Miss C. M. Cousins and other members of the N.I.R.D. staff for the help they have given in the trials.

★ ***NEXT MONTH***

Some articles of outstanding interest

Myxomatosis and the Fox by R. A. LEVER, C. J. AMOUR and H. V. THOMPSON ● **Economic Structure of Welsh Farming** by E. A. ATTWOOD ● **To Point of Lay** by R. COLES ● **Ragwort Poisoning** by L. G. DONALD.

Month in the Forest

J. D. U. WARD

Tanbark—Coppice—Wattle-making

MAY is often the nearest approach to a slack month in the whole year's round. Now the forester gets his chance to look at fences and gates and similar jobs that cry out to be done some time, yet have so far continued to be casualties of more urgent work. Sowing and planting is finished, major weed growth has not developed, and May is a time when shooting tenants will like any pheasant coverts left as quiet as possible.

Dollar shortages are in some places reviving an ancient springtime "harvest" that has been generally neglected for over fifty years. I refer to tanbark. The barking season runs roughly from April 20 to June 10. In the last ten years I have chanced two or three times upon barking operations in May. Formerly oak bark was of such value that it was usual to fell oak at this season especially to get the bark when it was both richest in tannin and most easily ripped from the trees. And if May felling was not feasible for one reason or another, the trees might yet be barked then, as they stood, and left as naked ghosts in the woods for felling the following winter.

The tanbark business was more or less killed by the development of trade with South America, whence cheaper tanning materials (quebracho) were imported. Since then Britain has found her considerable stretches of oak coppice something of a problem. While tanbark was in demand, the system was to cut on a rotation of about twenty-five years. The stripped poles might provide some useful fencing material or even small pitprops, and the surplus was either used direct as firewood or it was charcoaled. But charcoaling went out, to some extent, about the same time as tanbarking—and has incidentally enjoyed a mild revival at the same time as tanbarking. By the way, both jobs can rank, with farming, among the most ancient of all human activities. Sometimes a direct local connection between stock-raising, or rather stock-butchering, and long-established oak coppices can be detected: the tanbark was most needed where the hides and skins were in best supply.

And for those who spare a curious glance to the countryside without thought of today's £ s d, another point may be recalled. Many of the former tanbark oak coppices, now in a state when you don't know whether they should be classified as neglected coppice or merely scrub woodlands, are the cause of some misunderstanding. Anti-conifer and pro-oak enthusiasts of the well-meaning but uninformed country-lover kind look at them and say, "Our forefathers could grow oak here. Why can't you?" And the short answer is usually that growing twenty-five-year-old coppice poles is one thing, but growing oak high forest timber is quite another, requiring a richer and deeper soil.

Coppice (a word often misused but properly meaning a woodland which is cut on regular and fairly short rotations so that multiple new stems shoot from the stools) is in truth a poor, primitive type of silviculture, not gener-

ally in gear with modern requirements in such a country as ours. It is still the best way of getting the largest weight of firewood in the shortest time, and is thus useful in, for example, India. But we no longer grow alder coppice specially for charcoal for gunpowder; and sweet chestnut coppice (usually for hop-poles and split chestnut fencing) is uncommon outside Sussex and Kent. Of course, the farmer's favourite and most useful wood in many places used to be ash coppice, since it yielded ash poles of various sizes for a multiplicity of purposes—fencing, feeding cribs, shafts, wheelbarrow and plough handles and so on. Ash was, indeed, the most useful all-round wood on a farm before larch became common or technologists busied themselves with steel.

Another favourite species for coppicing is of course hazel, which provides the raw material both for wattle-and-daub buildings and, more recently, for wattles or hurdles for sheep folding. The sad position of hazel coppice is outlined and discussed in the Forestry Commission's Bulletin No. 27, *Utilisation of Hazel Coppice*.* Great Britain has about 167,000 acres of hazel coppice, and all our hazel needs could be supplied by 12,000. Most of the surplus is south of the Thames, from Kent to Wiltshire and Dorset, with Hampshire (33,000 acres) the most heavily oversupplied. The Forestry Commission advice on the subject might be summarized as "Don't grow hazel unless you have a good market. Convert your hazel coppice into high forest of another species." Though it is a dreadful heresy—even a kind of treachery from a forestry point of view—I suspect that some hazel coppice would in fact be best grubbed and the land converted to agriculture, just as in other places poor agricultural land might best be transferred to forestry. But much of the hazel coppice is not pure. It grows as an under-storey to widely spaced standard trees, usually oak, in the familiar coppice-with-standards system. And here a forester may be faced with a costly and awkward job. On many private estates, and especially within three hours' drive of London, the owner may take the line that since his woods produce far more from shooting rents than from anything else, he should leave well alone—or rather take the gamekeeper's advice on what is best for the pheasants!

This situation has its ironies. Though there may be a reduced demand for sheep-wattles, more of the very similar garden-shelters could probably be sold. But there is a lack of craftsmen keen on the work. It is, of its nature, a lonely job—and men who like to work alone all day in solitude are now scarce. Wattle-making, as a rural underwood industry intimately allied with agriculture, has never fully recovered from the knock which it took rather more than fifty years ago, during the time of agricultural depression. Incidentally, the hazel coppices also provide spars, spitts or broches and ledgers, liggers or sways which thatchers need. But thatching, as everyone knows, is another craft adversely affected by the dislike of loneliness.

* Obtainable from H.M. Stationery Office, price 10*s*.

Regional Organization of the Ministry

FOLLOWING the recommendations of the Arton Wilson Committee (Cmnd. 9732), a new regional organization of the Ministry came into force on April 1. From that date the former "provinces" of the Ministry are superseded by "regions". With the exception of the administrative county of the North Riding of Yorkshire, which will become part of the Northern Region, no regional boundary changes have been made. A list of the regions, the divisions which they comprise and the addresses of regional and divisional offices appears on pp. 91–2.

In Wales the functions of the Regional Controller will be carried out from the Welsh Department by the Welsh Secretary.

As suggested in the Wilson Report, the Minister has decided to reorganize the executive and allied work of the present sixty county offices in England and Wales into a smaller number of divisional offices, each under the charge of a Divisional Executive Officer, who will be responsible to the Regional Controller.

In those county centres which will not become divisional office sites, the Ministry will retain area offices. The county N.A.A.S. officers and local field staff will be based on these offices, which will be available for calls and inquiries by farmers who do not find it convenient to get in touch with a divisional office.

	Regional Office Address	Division	Divisional Office Address
Northern Region	Government Buildings, Kenton Bar, Newcastle-on-Tyne 3.	Cumberland Westmorland	Bitts Park, Carlisle.
		Durham	Elvet House, Hallgarth Street, Durham.
		Northumberland	4 Northumberland Street, Alnwick.
		Yorks (N.R.)	Government Buildings, Crosby Road, Northallerton.
Yorks/Lancs Region	Block 2, Government Buildings, Lawnswood, Leeds 16.	Lancs	Government Buildings, Cop Lane, Penwortham, Preston.
		Yorks (E.R.)	St Mary's Manor, Beverley.
		Yorks (W.R.)	Block 7, Government Buildings, St. George's Road, Harrogate.
East Midland Region	Block 2, Government Buildings, Chalfont Drive, Nottingham.	Derbys Notts	Block 7, Government Buildings, Chalfont Drive, Nottingham.
		Leics Northants Rutland	Government Buildings, Gladstone Road, Northampton.
		Lincs (Lindsey)	Greetwell House,
		„ (Kesteven)	Greetwell Road, Lincoln.
West Midland Region	Woodthorne, Tettenhall, Wolverhampton.	Cheshire Staffs	Berkeley Towers, Nantwich Road, Crewe.
		Salop	Abbotsfield, Sutton Road, Shrewsbury.
		Herefords Worcs Warwicks	Block C, Government Buildings, Whittington Road, Redhill, Worcester
Eastern Region	Anstey Hall, Trumpington, Cambridge.	Cambs Beds Hunts & Soke of Peterborough	Castle Hill House, High Street, Huntingdon
		Herts Essex	Beeches Road, Chelmsford.
		Lincs (Holland) Isle of Ely	Government Buildings, High Street, March, Cambs.
		Norfolk	Sprowston Hall, Wroxham Road, Norwich.
		Suffolk, E. and W.	Southgate, Bury St. Edmunds.

continued over

REGIONAL ORGANIZATION OF THE MINISTRY

	Regional Office Address	Division	Divisional Office Address
South Eastern Region	Government Buildings, Coley Park, Reading.	Kent	Mote House, Maidstone.
		Hants Isle of Wight	Government Office Buildings, Christchurch Road, Winchester.
		Oxon Bucks Berks	Marston Road, New Marston, Oxford.
		Surrey Sussex, E. Sussex, W. Middlesex	Elgin, London Road, Guildford.
South Western Region	Block 3, Government Buildings, Burghill Road, Westbury-on-Trym, Bristol.	Cornwall	Agar Road, Truro.
		Devon	Government Buildings, Alphington Road, Alphington, Exeter.
		Dorset Somerset	Blagdon Lodge, Middleway, Taunton.
		Glos Wilts	Elmbridge Court, Cheltenham Road, Gloucester.
Wales	Caerleon, 8 Victoria Terrace, Aberystwyth, Cardiganshire.	Anglesey Caerns Merioneths	Bryntysilio, St. Davids Road, Caernarvon.
		Brecon Radnor Montgomerys	The Lindens, Spa Road, Llandrindod Wells, Radnorshire.
		Cards Pembrokes	Government Buildings, Pontfaen Road, Lampeter, Cardiganshire.
		Carms	Priory Hotel, Church Street, Carmarthen.
		Denbighs Flint	Station Road, Ruthin, Denbighshire.
		Glam Mon	Government Buildings, Gabalfa, Cardiff.

Farming Affairs

Talking about poultry

With chicks growing, the numbers of stock on the farm will be increasing this month, and existing labour will have a job to cope with the work. This especially applies where the young stock are being reared on range, often quite apart from the main poultry flocks.

One major headache has always been the provision of water to the growing stock. Broadly speaking, a thousand growers on range will need something like half a ton of water a day, and I see no reason why this has to be carried.

If piping is provided the water will move under its own power to where you want it, and it can be piped either under or on top of the ground. Where we think of range growers, it is quite practical to lay a plastic piping on top of the ground and the job can be done by farm labour. For example, to water 10 acres of range will need the following tackle.

750 feet of ¾ in. alkathene piping	£41
4 couplings: 6 tees and 6 ball-valves will cost around ...	£7
6×50 foot lengths of ½ in. hose about	£9

Thus we have the essentials in the region of £57 and to this we should add a couple of days' work for the farm labour and water troughs which you may already have in stock.

May I suggest that if you carry water out to range it is worth working out properly how much this costs you daily, then check how it compares with this simple surface layout at around £57 per 10 acres.

Looking at poultry-keeping water supplies generally, there are two points which strike me. Firstly, how crude and elementary layouts often are, and secondly, how much money a good layout would save the owner in a year. It is worth noting, too, that your C.A.E.C. will have a man who can give you practical advice, and furthermore, that in some cases grants are available for permanent layouts.

Following the price review, it is obvious that every egg producer will be looking round to see where savings can be made. Having travelled many farms, I know that if I mention feed waste everyone will agree that this is a matter that someone else ought to do something about! There is no doubt that we do waste a great deal of feedingstuffs, both as mash or pellets and with heavy-handed grain feeding on range.

Let us look at a hundred layers. If they waste about 10 lb per cwt, then this hundred layers will lose 1,000 lb of food per year, which approximates to 7*s.* per week or 3*s.* 6*d.* per bird a year. I know that a loss of 10 lb in 112 lb seems ridiculous, but it can and does happen to some people, and a simple check can be carried out if sheets of paper or tin are placed under the feed container. Such a check is not, of course, one hundred per cent correct, but it has given many of my friends some unpleasant surprises, and it is certainly worth trying out—or persuading friends to do so if your own layout happens to be perfect!

Stopping waste from mash hoppers really boils down to five things.

1. The right hopper for the age group and enough feed space.
2. Stop the birds getting in and scratching the food out.
3. Some form of beading or lip on all troughs to stop the birds which "beak-hook" the stuff over the edge.
4. Don't fill them too full.
5. Don't leave it to someone else to check.

C. T. Riley

At the Farmers' Club

IDEAS FROM NEW ZEALAND

New Zealand's economy can be said to revolve round her grass and so, when two acknowledged experts on pasture management visit that country, it is only natural that they should come home with ideas that might be put into practice here. These ideas and much interesting information about New Zealand sheep and dairy farming were given to members of the Farmers' Club by MR. IVOR MORRIS and MR. TED OWENS in a joint paper on April 3.

MR. IVOR MORRIS is a sheep breeder who farms some 650 acres in Gloucestershire, and he is Chairman of the Wool Marketing Board. British sheep farmers, he suggests, could profitably follow New Zealand's example in a number of ways.

Fencing is one of the most effective investments in New Zealand. It is essential for controlled grazing, which, although it is the key to maximum pasture productivity, is rarely used effectively here. Many acres of medium-fertility land in this country could be made more productive if we followed suit. An extra ewe per acre would well repay the cost of fencing. In New Zealand it pays to fence at £700 per mile! "I have done fencing at home at a cost of about £500 per mile," said Mr. Morris, "which suggests that an even greater return on the capital involved can be obtained." Reseeding can be useless without adequate fencing to keep stock off in the early stages and to control grazing later—a matter of special importance in reseeding schemes on our marginal lands.

Because of differences of climate and soil, the spreading of fertilizer from the air is unlikely to give such striking results in Britain. But much of our hill land is sour, and work in New Zealand demonstrates that some acid soils respond well to a moderate dressing of lime plus a minute quantity of molybdenum. Trials in this country might prove valuable; if low rates were effective, aerial top dressing might well be economic.

New Zealand research shows that, given a sufficient density of stocking, sheep can themselves deal competently with all the pasture; the grass need not be shared with cattle, and the incidence of worm infestation is not developed. The rate of stocking per acre in this country could be increased considerably without a large degree of unthriftiness from worms.

If, as in New Zealand, we concentrated more on improving grazing and fleece weights, fewer breeds with wider adaptability would suit our industry better.

New Zealand farmers spend nearly £60,000 a year on advertising their meat in this country; this sum comes from a trifling deduction of 0.05*d.* per lb on carcasses passing through the freezing works. Mr. Morris accused us of "spending nothing and doing little".

MR. TED OWENS, who farms in Somerset, was astonished that the New Zealand dairy pastures could be so productive. They are often full of weeds and poor types of grasses. Yet butterfat production per acre and per cow is so high. "Just how and why does the New Zealand cow do this?" he asked.

Could it be that the calves are reared on grass almost from birth? Do they learn to deal with the bulk better for getting it at such an early age? Do they develop a better stomach flora from doing so? Does the cow herself maintain a more suitable stomach flora because she is living entirely on grass or grass silage and hay?: that is to say, do we damage our cows' digestions by too much concentrates?

Does New Zealand automatically select the best grass utilizers in selecting the best producers? If this is so, we have only ourselves to blame for the fact that we have a national dairy herd of cows selected to produce from expensive concentrates. If this is so, we have a big job of rebreeding our cows to do a sound job on cheap good grass.

"If the dairy industry of this country could halve its concentrates fed to cows, perhaps at the cost of a slight reduction in sales of milk per cow," said Mr. Owens in conclusion, "it might ease the present pressure on milk selling and, cutting costs more than yields, improve the present level of profitability."

Tractor sense

Tractors on field work more often come to a stop from wheel spin than from engine overload, but bad wheel grip has another and less easily noticed effect on efficient tractor operation. It is possible to have as much as 20 per cent slip without the driver being aware of it.

A rough estimate can be made of the extent to which driving wheels are slipping when the tractor is dealing with a given traction load. First, paint a mark near the rim on one of the wheels so that the number of revolutions can be counted easily, put the implement into work and use pegs to mark the distance the tractor travels while the driving wheel makes ten revolutions. (If the tractor is being used for ploughing with one rear wheel in the furrow, the landside rear wheel is the one to be counted.) Measure the distance between the pegs and then unhitch the implement (or raise it out of work if it is directly attached to the tractor), run the tractor free, and measure the distance it travels for ten revolutions of the driving wheel. The percentage of slip is approximately the difference between these two distances divided by the distance travelled without load and multiplied by a hundred.

If the percentage of slip is more than 15, then something ought to be done to reduce it. The grip of driving-wheel tyres can be improved by adding ballast or by reducing the pressure of air in the tubes. Working the tyres at too low a pressure is bad for them; heavy ballast with the tyres pumped-up harder to withstand the additional weight is the surer way to improve grip, but it is now thought that on some land a heavily ballasted pneumatic-tyred wheel can damage the structure of the soil. For this reason, fitting strakes to the tyres to improve grip may be a better method than employing high weights of ballast, though it must be remembered that many types of strake are themselves rather heavy. Retractable strakes, when the tines are withdrawn for the tyre to be in contact with the soil in the ordinary way, can provide quite a large ballast.

There are some jobs and circumstances for which it is better to fit spade-lugged steel wheels than to use either tyres-plus-strakes or heavily ballasted tyres. With a little practice, the changing of rear tractor wheels can be done quickly and easily. When the tractor goes to work along the road its steel wheels and a jack can be towed behind on a trailer and the wheels can be changed as soon as the outfit gets inside the field. A wide plank of wood put under the base of the jack will prevent it sinking into soft land.

The grip of steel wheels can be improved sometimes by ballast to cause deeper penetration of the lugs into the soil, and the extra weight is not likely to have any bad effect on the soil structure. Lack of grip with steel wheels is, however, more often due to the spade lugs being worn short and round than to lack of weight. There is rarely any need to estimate the slip by counting wheel revolutions. The range of slipping over which a spade-lugged wheel can continue to work is small. A steel wheel that is slipping seriously soon digs itself into the soil. If the impression left in the soil by the spade-lug when the tractor is pulling hard retains about the same shape as the lug itself, the wheel is gripping satisfactorily, but an enlarged imprint shows that there has been some slipping.

H. J. Hine

"Science and the Farmer"

The Ministry's exhibit at this year's Bath and West Show (29th May–1st June) takes as its theme the development in agricultural science and education from the late eighteenth century to the present time and also looks into the future. For the first time in the history of agricultural shows, a number of agricultural education and research authorities are joining forces with the Ministry and the Bath and West Society to present an educational exhibit which will be of outstanding interest to farmers, students, and townsmen and women generally.

A spectacular feature will be a ploughing demonstration between a team of oxen and a radio-controlled tractor. Our cover picture shows the oxen which the Earl of Bathurst is kindly lending. Old farming operations, implements and type of stock which were common sights in the time of "Farmer George" will be shown, and, of particular interest to housewives, the kind of farm kitchens which were formerly the centre of the little world of the farmer's wife and family.

Present-day activities and interests will be reflected in farming techniques, the control of animal disease, and the emphasis on agricultural education. In the future are shown something of the possibilities of semen banks for artificial insemination, the influence of hormones in apple-growing, the use of isotopes in plant physiology, artificial rearing of pigs, insulation and ventilation of farm buildings, improved water supplies and the shape of machinery to come.

The venue will be Stand No. 366 in Avenue J. Be sure you and your family do not miss it.

In Brief

TRACE ELEMENTS IN PLANT NUTRITION

Trace elements in plant nutrition, with special reference to crops, was the subject of Professor T. Wallace's Fernhurst lecture to the Royal Society of Arts this year. Great strides have been made in recognizing and controlling the injurious effects of trace element deficiencies and excesses on crop yields and quality, but treatment should be given only after diagnosis. Using "shot-gun" mixtures of trace elements in fertilizers, as a routine preventive, is wasteful.

Professor Wallace described the appearance of crops suffering from shortage or excess of the seven essential trace elements—iron, manganese, boron, copper, zinc, molybdenum, and chlorine. Soil conditions, such as acidity, organic matter, microbial activity, drainage and aeration, which can affect availability, must be corrected where possible. Otherwise, adding the deficient element may have little effect, or necessitate using wasteful or uneconomic amounts.

Iron deficiency is generally induced by high soil pH, which can be lowered by sulphur dressings. Spraying the foliage with iron chelate compounds (0.1 per cent) is very effective. Manganese deficiency is often due to high pH in poorly-drained soils with high organic matter. Cereals and other farm crops can be sprayed with manganese sulphate (5–10 lb in 100 gallons of water per acre) and the soil treated to lower pH.

For boron deficiency, causing Heart Rot and Brown Heart in sugar beet, mangolds, swedes and turnips, 20–40 lb borax per acre added to the soil is preferred to spraying. Dressings should be given only when susceptible crops are being grown on boron-deficient land. Copper deficiency is corrected either by using fertilizers containing copper at rates varying with soil type, or by spraying the foliage with copper sulphate (0.5–1.0 lb in 100 gallons of water per acre). Zinc deficiency is best treated by foliage sprays. Soil molybdenum is made more available by liming, or sodium or ammonium molybdate can be used in fertilizers or spray, usually at 1–2 lb per acre. Chlorine shortage is corrected by using kainit, agricultural salt or muriate of potash. Excess of most trace elements can be corrected by liming.

SILAGE AND SAFETY

We hear of accidents nearly every year when tractors again start rolling silage heaps. A heap of silage with no support to the side is always apt to be unstable, and if a tractor is driven too near the edge the material may slip and let the tractor down. It nearly always overturns, and the driver is injured, sometimes killed. Tractors should be kept well away from the edges of heaps unless these are made safe by a really strong support—there are several types on the market and they do make for greater safety.

Silage material is queer stuff to drive over when a heap is being made. As each load is spread, the top is loose and the tractor wheels sink in to a greater or less extent, whilst on the ramp leading up the material soon gets compressed and is often very moist. In those conditions the tractor may stall

or the back wheels begin to spin. This is the time to be careful how the clutch is used, for if the engine revs are high and the clutch is let in suddenly, the snatch may cause the front of the tractor to rise. It may then turn over backwards or slew round and go over sideways.

TAKING THE CREDIT

The banks should appoint their own farm credit officers and develop closer co-operation with the N.A.A.S. and the University Agricultural Economics Departments, writes Mr. Alan Harrison in a recent issue of *The Farm Economist*. In this way, capital could be placed in the hands of those farmers who not only need it but could be relied upon to use it effectively. This is Mr. Harrison's answer to the criticism, which he thinks has some justification, that the banks are over-concerned with obtaining collateral security. It is certainly an interesting suggestion, and is not without precedent since the agricultural banks in the U.S.A. have relied upon technical advice and assistance in the making and supervision of farm loans for many years now.

Mr. Harrison gives some useful new facts about the seasonality of credit needs. He takes a sample of 172 farms and estimates their credit position month by month through the farming year. He finds that in September, when farmers' indebtedness is greatest, there were 90 farms with overdrafts totalling £57,303, and 82 farmers with credit balances totalling £42,651. By contrast, in February there were 50 farms with overdrafts totalling £20,822 and 122 farms with credit balances amounting to £97,312. Thus, on balance, the group of farms lent more than it borrowed—that is, these farmers were financing other sectors of the economy.

Mr. Harrison feels that there are farmers who could use more credit than they can get at present, and he would like to see some scheme whereby the farmers with surpluses could help their more needy neighbours. He envisages a central source of agricultural credit—a sort of financial farming "pool". It is an intriguing idea, but one which is hardly likely to commend itself to the banker who, after all, makes his living by accepting Peter's money and lending it to Paul and is not much concerned about the identity of either.

WOOD PIGEON—A NATIONAL SCOURGE

Mr. G. H. Tawell, writing in the April issue of *The British Farmer*, sees our wood pigeon problem as arising directly from the efficiency of modern farming. Every advance in chemical weed control has deprived the wood pigeon of some of its natural foods. The fields of concentrated foods—corn, young clover, peas and the winter green crops such as Brussels sprouts, kale and cauliflowers—are readily available and well suit "the locust-devouring appetite of large flocks".

"It is estimated that the damage by pigeons to the Brussels crops alone (including produce spoilt for market and costs of replanting) amounts to £400,000 per annum. Add to this the cost of maintaining tens of thousands of mechanical bird scarers (which cost from £12 to £15 apiece in the first place), the cost of cartridges and labour, and you have a very formidable figure."

Mr. Tawell, who farms near Dunstable, Bedfordshire, urges that the only effective means of destroying the birds, which he describes as "a national scourge", in numbers sufficient to make appreciable difference is to get the birds in their breeding quarters in the breeding season—from June to November. There are several generations a year; if one nest is destroyed another is soon built and more eggs laid. The birds nest in woods, largely on

the outskirts, but also deeper in, in odd deciduous trees low down or high up, and extensively in hedgerows. Besides hard shooting in winter, Mr. Tawell urges that a special point should be made of persistently destroying the nests from July to October year after year. And this requires the co-operation of a good many people—farmer, grower, landlord and occupier—neighbours all.

LIQUID FERTILIZERS

Fertilizers in solution were reviewed by Dr. N. H. Pizer (N.A.A.S.) at a recent meeting of the Fertilizer Society in London. He described two techniques developing rapidly in the United States—injection of liquefied ammonia gas (anhydrous ammonia) below the soil surface, and direct application of fertilizer solutions—and discussed their usefulness for our soil and crops, surveying in detail the nature of the different liquids involved, and the practical problems of handling them.

Liquefied ammonia gas (82.2 per cent N) requires pressure equipment standing up to 250 lb per square inch. It is readily absorbed and retained by light soils and could be used for top dressing wide-row crops like kale, or for grass, but it damages cereals. Low-pressure solutions (10–15 lb per square inch) of ammonia in water, alone or with urea and/or ammonium nitrate, giving 25–40 per cent N, are easier to handle, but they still need special placement equipment and are very corrosive. Pressure-free solutions of ammonium nitrate, urea, or sodium nitrate combinations, can be run straight on to the soil. They are likely to deposit solids in storage tanks and field equipment. The need for complete fertilizers limits the range of these nitrogen solutions, but they may be more effective than solids if used as top dressings between the rows in dry periods.

Liquid mixed fertilizers are likely to be as effective as solids of the same composition. Field experiments would show whether they have advantages here. For horticultural crops, if phosphate and magnesium are supplied as solids, most nitrogen and potash requirements are met by N:K ratios of 1:1.5, 1:1 and 1.5:1. Quantities of different materials to make these mixtures are tabulated. Urea is particularly valuable, owing to its high solubility and high N content.

In discussion, Dr. G. W. Cooke of Rothamsted suggested that on light soils with satisfactory phosphate status, sugar beet might be a suitable crop for liquid nitrogen fertilizer, applied on a contract basis, using kainit to supply potash. On kale, anhydrous ammonia is as effective as solid nitrogen fertilizers. Professor J. W. Melsted, from Illinois, said that in the United States contractors apply liquid nitrogen at about £1 per acre and about 6*d*. (6¾–7 cents) per lb of nitrogen. Thus it is substantially cheaper than solid nitrogen. The full text and discussion is available in the *Fertilizer Society Proceedings*.

COW SAVES FARMER TIME

Four orphan lambs have been adopted by a Jersey cow in New South Wales. This strange foster-parenthood was first discovered when the farmer noticed that the cow's milk supply was irregular. But since this natural solicitude saves the farmer the trouble of first milking the cow and then filling bottles to feed the lambs, he is not disposed to disturb the arrangement.

Book Reviews

The Farmer and Stock-Breeder Grassland Handbook. Farmer and Stock-Breeder. 21*s*.

The ever-mounting literature on grassland bewilders the farmer and dismays the adviser. This handbook does neither. It grapples with imponderables and conveys a wealth of information in 286 readable pages. The standing and reputation of the 17 contributors is beyond dispute and the distilled wisdom which flows from knowledge and experience is set down simply.

No attempt should be made to read the book at a sitting; it is essentially an up-to-the-minute reference book for farmers and advisers. It deals, as one might expect from the title, with cheaper and better grass; strains of herbage plants; their suitability in various seeds mixtures; as well as lucerne and its increasing importance in British farming systems. The virtues and short-comings of the grasses and clovers commonly used in this country are summarized conveniently in tabular form with interesting and valuable information on the proper use of the new bred strains.

The authors advocate greater use of fertilizers on grassland, stating that in 1955 only 27 per cent of the grassland in this country received phosphate; with leys, the figure was 36 per cent, and only 17 per cent received potash and 31 per cent nitrogen. The point is well made that if the standard of farming achieved in grassland was equal to that achieved in the best arable districts the picture would be very different. It is suggested that the output per acre obtained with sheep and cattle is insufficient to allow expenditure on fertilizers and other forms of grassland improvement, except at rates well below those practised on our more intensive dairy farms. Much has yet to be learned about the profitability of meat production under more intensive systems of grassland management, and further work on this problem is urgently needed.

No book on grassland would be complete without a full account of silage and silage-making. Chapter 6 deals comprehensively with this subject under the heading of "Modern Silage Making". The handbook concludes with a very convenient month-by-month calender of grassland work. Timeliness has long been recognized as the greatest single factor in successful arable cropping: the same lesson has yet to be learned by the grassland farmer.

In compiling and producing this handbook, the *Farmer and Stock-Breeder* have performed a valuable service to the industry.

T.W.E.

A History of British Livestock Husbandry to 1700. ROBERT TROW-SMITH. Routledge and Kegan Paul. 32*s*.

This is the first book to be devoted solely to the evolution of our cattle, sheep, pigs and horses—always high in the list of our major national assets. It is not a work of original scholarship, but it makes effective use of the findings of modern scholarship and so brings to the general reader a substantial and stimulating sample of the new agricultural learning which research is making available.

The story begins with the neolithic farmers who reduced the aurochs to some kind of agricultural discipline—incidentally, the layman, remembering that German scientists have outwitted history by rebreeding a fully operational specimen of this extinct ox, may wonder if genetical evidence for these early times has been fully exploited. It continues through the Bronze Age, which produced the first cowhouse, to more familiar later periods, where we watch the cow becoming a source of milk and meat rather than the mother of pulling-engines, the sheep turning from milk-producer to wool-provider, the aristocratic horse humbling itself to the plough, and the pig slowly deserting the woods for the field and the sty.

It is a fascinating tale, enlivened by references to such picturesque incidentals as the tenth century Stockman's Insurance Association and the cowmen of the turbulent northern borderlands milking with their swords beside them. The manner of its telling and interpretation reflect the author's agricultural experience as well as his historical knowledge. Clearly, the book

has a part to play in the general revision of our farming history which is now taking place.

Mr. Trow-Smith's subject is vast; indeed, at times the material becomes unwieldy and the narrative suffers. But certain generalizations emerge. One is the high standard of management on the better farms, illustrated in its extreme form by the not uncommon medieval practice of housing sheep in hard weather. Another is the early commercialization of farming; the unexpected mobility of stock and the ambitious upland cattle-ranching enterprise of the Earl of Lincoln in the thirteenth century are examples of this.

A third is the repressive effect of the pervading shortage of fodder. Mr. Trow-Smith finds no evidence to support the "autumnal slaughter" tradition—it would be interesting to know the source of this widespread belief—but significantly ends his book at the coming of the new forage crops, which were to make possible a revolution in stockbreeding and the development of the farm animals we know today. Fortunately, he has promised to bring his valuable contribution to agricultural history down to modern times in a second volume, which is now in preparation.

N.H.

Plant Protection Conference 1956. Butterworths. 50*s*.

The Second International Conference on plant protection took place last year at Fernhurst, in magnificent June weather. All the delegates were greatly impressed with the excellence of the arrangements made and the thoughtfulness shown by Plant Protection, Ltd., who were acting as hosts.

Noted scientists from overseas who attended included Dr. E. Åberg from Uppsala, Dr. R. L. Metcalf from California, Professor H. Müller from Germany, Professor K. T. Suchorukov from the U.S.S.R., and Professor Truhaut of France.

With the publication of the proceedings of the conference, the work accomplished may be read by all those doing research on crop protection. For such, this is a very useful review, but it is intended for the scientist rather than for the farmer.

In the first chapter, Sir Frank Engledow and Dr. J. G. Knoll review world aspects of crop protection, dealing particularly with governmental work and responsibilities on an international plane, and the need for crop protection courses in our universities.

Genetics in relationship to crop protection gets a very useful chapter. Dr. W. F. Hanna considers at length the rusts of wheat and reaches the conclusion that "the only practical control of wheat stem rust in sight at present, other than by growing resistant varieties, is chemical control".

Professor Suchorukov gives a physiologist's approach to the immunity of some agricultural plants. He states that it has been found that wilt resistant plants possess a denser wood, larger medullary rays with a greater starch content, smaller intercellular spaces, and thicker cell walls. Rust resistance in wheat has been raised by an increase in nitrogen.

Dr. R. L. Knight discusses authoritatively Blackarm disease of cotton and there is a very interesting chapter on "Mechanism of Toxicity with Special References to Fungicides" by Dr. S. E. A. McCallan, who reaches the challenging conclusion that fungicides are less specific and less toxic than animal poisons, insecticides, herbicides and bactericides.

Dr. J. T. Martin deals with the mechanism of toxicity and concludes that the way is open to the employment of expensive but highly specific chemicals.

Systemic insecticides in agriculture are interestingly reviewed at some length by Dr. R. L. Metcalf, while towards the end of the book there is a chapter on the hazards of toxic chemicals in agriculture by our leading expert in this field, Dr. J. M. Barnes, who is a firm believer in soap and water! Dr. R. Fabre and Professor Truhaut thoroughly consider the hazards of toxic residues in food and in so doing clearly indicate how European toxicologists are thinking.

Finally, Dr. R. P. Fraser deals very ably with the scientific and engineering problems involved in producing sprays of different characteristics.

In such a short space it has not been possible to do justice to all contributors, but enough has been said to indicate that there is something of interest to most crop protection specialists. To Plant Protection must go a special word of congratulation on the enterprise they have shown and for making possible such a conference.

R. de B.A.

Potassium Symposium, 1955. International Potash Institute (Berne). 45*s*.

The twenty-six papers which were read at the International Potash Institute Congress held in Rome in 1955 are included in this 613-page report. The report also contains abstracts in English, French, German, Spanish and Italian, a list of the 661 authors quoted, and a subject index in five languages.

This Congress naturally succeeded the one held in Zurich in 1954, in so far as it dealt, but in more detail, with the functions of potassium in the soil and in living organisms, and with the economic importance of potash in agricultural practice.

A few papers discussed the forms and distribution of potassium in the soil and, particularly, the mechanism of the change of potassium in the soil into a state in which it is not available to the crop. Only a few clay minerals appear to possess the property of "fixing" potassium, but our knowledge is far from complete as to the relative extent to which they fix potassium and release it again for the needs of the crop. Fixation of potassium may explain why some potassium-deficient soils respond unfavourably to potassic fertilizers, and also why potassium added to a soil is only partially recovered in the crops within a reasonable period, the extent of recovery depending on the soil type. In some respects potassium fixation by soils may be beneficial, as it tends to retain the element temporarily in an unleachable state.

Other factors which influence the supply of potassium to the plant also received attention. For example, in soils which are intensively cultivated with heavy applications of organic and inorganic manures, the colloidal-chemical behaviour of the soil may be important in relation to the availability of potassium. Humus and the soil organisms living on the humus play an important part in the potassic cycle in the soil. Potassium is not strongly bound to the organic matter (dung or green manure). A substantial fraction is directly soluble in water and the rest is liberated by the microbial decomposition of the organic matter.

The supply of potassium to the plant is also influenced by the varying proportions of the other nutrients (ions) in the soil and the different requirements of plants for the individual kinds of nutrients. For example, nitrogen and potassium generally exhibit a positive interaction whereby one constituent promotes the uptake of the other (synergism). On the other hand, the relationship between potassium and magnesium is one of antagonism by which an excess of one nutrient reduces the absorption of the other. The above are only a few of the salient points covered by a selection of the papers entitled: "Potassium in Clay Minerals", "Potassium in Soils of Temperate Climates", "Release of Potassium in the Soil", "Potassium Fixation in Soils" and "Potassium and Organic Matter".

An interesting point revealed in a paper on the mineralogical problems associated with the potash salt deposits has been the discovery of argon—one of the rare elements in the atmosphere—in the potash salts. It has apparently been derived from the radio-active potassium (K^{40}) isotope. The argon content has been used to estimate the geological age of the potash deposits.

The book is obtainable from the International Potash Institute Ltd., P.O. Box Berne Transit, Switzerland (payment to be made through a bank or by postal order to the Institute's account at the Union Bank of Switzerland in Berne), or through any bookseller.

G.A.C.

The Agricultural Significance of the Hills. (Studies in Rural Land Use—Report No. 3). B. R. DAVIDSON and H. P. WIBBERLEY. Department of Agricultural Economics, Wye College. 5*s*.

The agricultural importance of the hill and upland areas of Great Britain is often stressed. This study by Wye College is essentially an exercise in defining these areas, and in measuring physically and financially their contributions to the country's total farming output. The "broad factual position" which emerges, with conclusions based thereon, about the magnitude of the contribution, the cost of getting it, and the relative efficiencies of upland and lowland farming, occupy 28 pages. Another 35 pages contain details of methods and calculations, stage by stage.

The marshalled figures are impressive and the magnitudes substantial. Obviously, acceptance must depend on the source materials and the methods used. Once figures get into print they are liable to gain currency by repetition, with insufficient regard for the foundations on which they rest. The authors claim that various

checks and revisions (not described) confirm the general level of the findings.

Sheep provide the major part of the farming output from the higher lands, and the organization of the sheep enterprise in British farming is perhaps the most varied and difficult to crystallize into facts and figures. Relying heavily upon the method of the raised sample, it is important that the samples used should adequately represent not only the complex universe of sheep husbandry, but also the associated beef and dairy cattle raising, milk production, and other subsidiary activities.

Having broadly defined the scale of hill and upland farming by the numbers of ewes, breeding cows and other cattle subsidized under the Hill Farming and Livestock Rearing Acts, output and production costs are then calculated by using various unit measures (multipliers) derived from Farm Management Survey groups of farms, in England, Wales and Scotland respectively. There are disproportions between the respective samples and many of the assumptions made as to their representativeness will provoke challenge at many points throughout the report.

Thus English hill and upland farming is represented by a single group of no more than 40 farms, described as "Northern England" (p. 30). In fact, these farms are located in a relatively small and well-defined area on the east of the Pennines in Westmorland. Between the farming output and cost structures in this area and in those of other considerable hill and upland areas, even in the north of England, there are marked contrasts. The validity of assuming, for example, that average expenditures per acre on seeds, fertilizers, rent, machinery, etc., in the sample group are uniformly applicable to the whole hill and upland area in England (p. 39) is questionable.

Similarly as to labour costs, it is a bold assumption that the proportions of adult males, youths, boys, women and girls are uniform, at Welsh levels, throughout the hill areas (p. 53). It is also surely an oversimplification to suggest that the payment of subsidy on some hill ewes at full rate and others at half rate gives a clear demarcation line between hill land and livestock rearing land (p. 4). Again, the number of cows on livestock rearing land is not the same as the numbers on which subsidy is paid (p. 34).

Given the determination to make the picture, these and other rough yardsticks may be thought justifiable *faute de mieux*, but it may be safer to conclude that the realities of hill and upland farming have been less sharply focused than the precise figures imply.

The report is obtainable from the Department of Agricultural Economics, Wye College, near Ashford, Kent.

D.H.D.

Animal Nutrition (4th Edition). LEONARD A. MAYNARD and JOHN K. LOOSLI. McGraw-Hill (New York and London). 56*s*. 6*d*.

Any publication from the famous Cornell school of nutrition commands attention, and when the book happens to be the 4th edition of an already standard text one turns to it with anticipation. On this occasion Maynard has shared his labour with a distinguished colleague, but the joint authorship has not given rise to a new format. The chapter headings are those of the previous edition with the addition of *Antibiotics, Hormones and Other Growth-stimulating Substances* as the title of a new chapter.

But this is not to say that the content of each section has not been thoroughly scrutinized. On the contrary, even though the sub-heading of a paragraph may have a familiar ring, it is evident that every care has been taken to bring the contents right up to the minute, and the large number of references to work published in 1955 is proof of the industry and thoroughness which have gone into the revision. For example, the new knowledge of the nature of digestion in the ruminant has been employed to modify views on protein metabolism and the concept of biological value, and many references are made to the advances which have become possible by the use of radioactive isotopes.

The book is a miracle of compression in that every conceivable topic has received some treatment within the compass of 450 pages. This has of necessity made for sketchiness. Thus, although the events of the oestrus cycle are admirably summarized, all that is said of the mechanism is that "these events . . . are under the control of hormones". This criticism could be multiplied, but, in fairness, it must be admitted that the references to literature, both in footnotes and in the lists which follow each chapter, usually

point to where an awakened interest can be satisfied. I wish, however, that such an important theme as the citric acid cycle had received a full treatment. Although it is referred to as the metabolic pool in which the products of fats, proteins and carbohydrates are merged, it is not even indexed, let alone explained!

Those who are familiar with the previous editions will know that *Animal Nutrition* does not deal with day-to-day practical rationing but with the fundamental science of nutrition. Although there is little in the book to help the husbandryman directly, there are, nevertheless, many passages which require only a little interpretation to bring out something of real practical value. Of course, it is intended primarily for North American teachers, advisers and serious students, and the differences in management, climate, stock and available feedingstuffs make it necessary for readers in the United Kingdom to use more than usual caution when appraising recommended feeding standards. The difference between American and British experience is well shown in the discussion on minerals. There is great emphasis on the importance of iodine supplementation which is a more acute issue in America than here. Also, in this section, there is some need to clarify the account of copper-molybdenum-sulphate interrelationships. It is said that the level of inorganic sulphate "plays a role", but it is not made clear that high sulphate appears to worsen the effect upon the copper. In view of this, another statement made some twenty pages previously, that "a sulphur deficiency may also be involved", requires amplification. Finally, in British experience, trouble can be expected from less than 0·002 per cent (that is, 20 parts per million) of molybdenum in herbage dry matter.

The printing and paper are first class and the book is strongly bound and will stand up to the constant handling which its admirable contents so well deserve. It is rich in tables, diagrams and excellent photographs which convey their message very clearly.

S.M.B.

Books Received

The State of British Agriculture 1955–6. K. E. Hunt and K. R. Clark. University of Oxford, Agricultural Economics Research Institute. 10*s.*

Fertilizers: Production, Consumption, Prices and Trade in Europe and the United States, 1954–57. O.E.E.C., Paris. H.M. Stationery Office, London. 8*s.* (8*s.* 3*d.* by post).

Home Grown Threshed Peas Joint Committee Report for 1955. Pea Growing Research Organisation, Research Station, Yaxley, Peterborough.

1957 Catalogue of Books on Agriculture, Horticulture, Animal Husbandry and Veterinary Science. H. K. Lewis and Co., 136 Gower Street, London, W.C.1.

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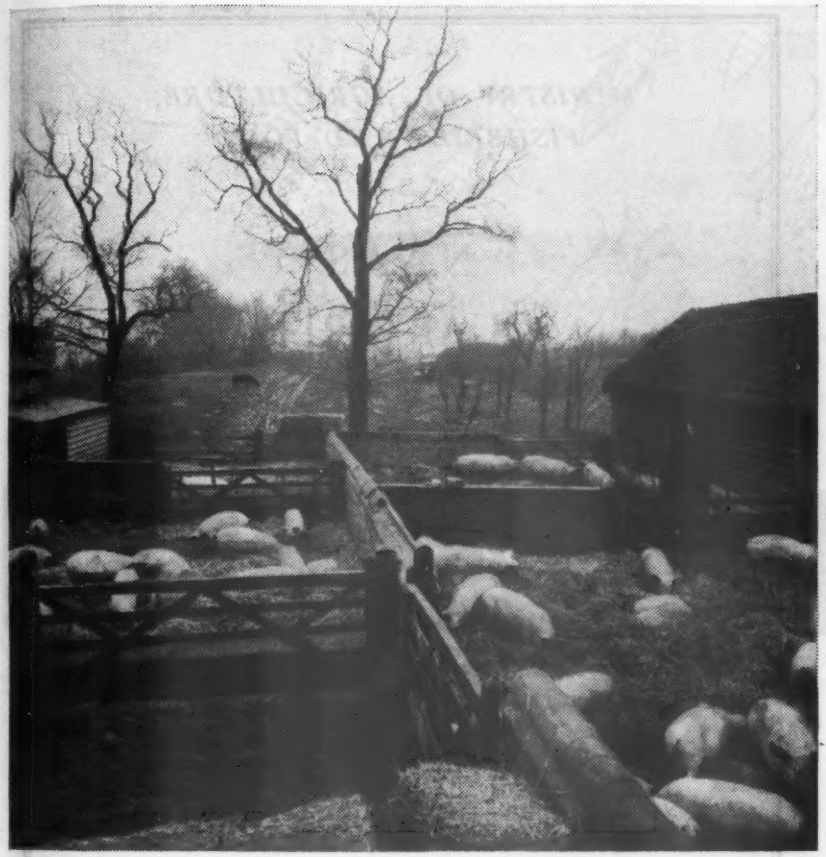

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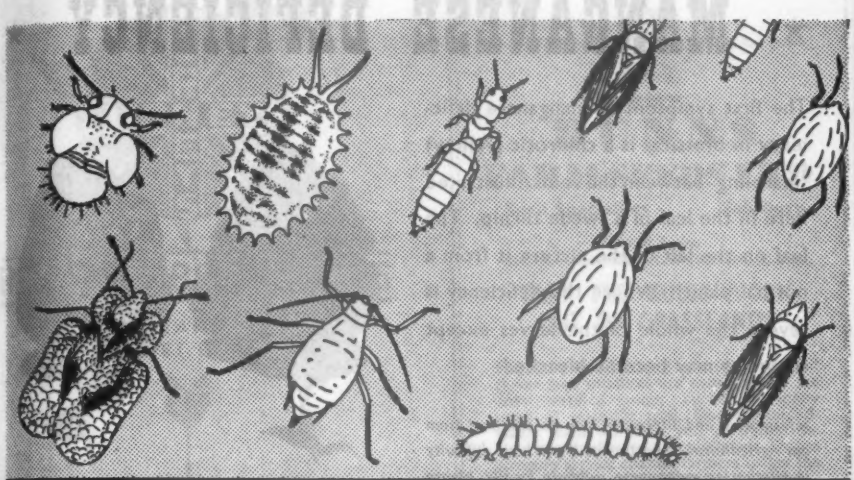

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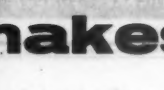

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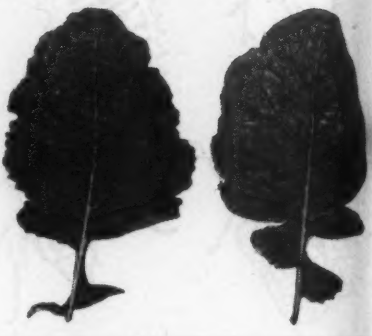

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ABINGDON'S famous Town Hall, with its noble pillared market space on the ground floor, was built in 1677-80 by Christopher Kempster of Burford. Kempster, a mason-contractor who later worked on St. Paul's Cathedral, was described by Wren as 'a very able man, modest, honest and trea- able.' His magnificent building was th fourth—or possibly fifth—market hou to stand on this site. Market day i Abingdon is Monday, as it has been fo at least the past six hundred years.

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